CITY OF VISALIA
LOWER KAWEAH RIVER & MILL CREEK SYSTEM
FLOOD CONTROL IMPROVEMENTS PROJECT
(SAP CONTRACT NO. 4600009930)

July 2015

Prepared for:

City of Visalia

Prepared by:

Provost & Pritchard Consulting Group
Visalia, California

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SECTION 1 PROGRAM BACKGROUND

1.1 Flood Protection Corridor Program

The Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Act of March 2000 (Proposition 13) created the Flood Protection Corridor Program (**FPCP**). In 2006 additional funds through the Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act (Proposition 84) and the Disaster Preparedness and Flood Prevention Bond Act (Proposition 1E) were disbursed into the FPCP. With these funds the FPCP pursues projects that provide protection, creation, and enhancement of flood protection corridors through various methods including acquisition of easements and/or property in flood plains, modification of existing levees, and construction of new levees. The funding sources require the grant applicant, with the Department of Water Resources, to develop a Plan to Minimize the Impacts on Adjacent Landowners (Plan) prior to acquiring any interest in land. The California Water Code Section 79041 states:

> *"Prior to acquiring an easement or other interest in land pursuant to this article, the project shall include a plan to minimize the impact on adjacent landowners. The plan shall include but not be limited to, an evaluation of the impact on floodwaters, the structural integrity of affected levees, diversion facilities, customary agricultural husbandry practices, and timber extraction operations, and an evaluation with regard to the maintenance required of any facilities that are proposed to be constructed or altered."*

As listed in the Code, this Plan must include an evaluation of the impact on floodwaters, the structural integrity of affected levees, diversion facilities, customary agricultural husbandry practices, and timber extraction operations, and an evaluation with regard to the maintenance required for any facilities proposed to be constructed or altered through the project. This Plan has been prepared by Provost & Pritchard on behalf of the City of Visalia (City) as part of the grant awarded for the City Flood Control Improvements Project. The project will construct new and expand existing flood layoff basins to increase flood protection for the City. Construction activity is currently scheduled to begin in 2015.

SECTION 2 PROJECT OVERVIEW

2.1 Project Background

The City is situated on the San Joaquin Valley floor, east of Highway 99 and along Highway 198. The City covers a 31.1 square-mile (19,926 acres) area that is approximately 11.8 miles from east to west. The City contains localized areas of residential housing, commercial businesses, industrial areas and recreational facilities and growth within the City is guided by regularly updated development plans. The area surrounding the City is currently developed to agricultural uses and as the City has expanded, agricultural lands have been converted to municipal uses and incorporated into the City.

Historically the City has been subject to flooding from the distributaries of the Kaweah River, including the St. Johns River, Mill Creek, Packwood Creek, and Cameron Creek. Significant historic flood control projects, such as the creation of Terminus Dam on the Kaweah River and the undergrounding of Mill Creek through the historic Visalia downtown, have reduced the risk of flooding in Visalia and increased public safety, but the existing storm water system through the City is not capable of containing large flood flows or preventing significant flood damage to large portions of the City. For this reason approximately 7,069 acres, or 35% of the City is designated as being within a 100-year flood zone. Flood areas throughout the City are shown by the Federal Emergency Management Agency (see Exhibit 1) as Zone AE, or areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. In these areas Base Flood Elevations have been determined and mandatory flood insurance purchase requirements and floodplain management standards apply. Flood depths across the City generally range from one to three feet largely depending on the proximity to the source of floodwaters.

Two creeks that will receive added flood protection benefits from the project are Mill Creek and Packwood Creek. Mill Creek is a regionally significant creek that flows east-west through the center of the majority of Visalia. As the City developed, much of the City's storm drain system was designed to drain into Mill Creek. Therefore when there are capacity issues in Mill Creek, like during flood events, waters that normally drain toward the creek back-up into City streets and begin to cause flood damage. Packwood Creek is also a regionally significant creek that flows northeast-southwest through southern portion of Visalia. Packwood Creek receives storm water from the southeastern portion of the City and experiences similar flooding issues to Mill Creek.

Given the very different flood corridors that contribute to flooding in Visalia, the City has developed a floodwater management strategy for different areas of the City. For this reason there are three project locations that are contained in the DWR Flood Control Improvement Project (Project): Goshen Basin Improvements, Oakes Basin Improvements, and Peoples Basin Improvements.

2.2 Project Goals

Goshen Basin, Oakes Basin, and Peoples Basin each plays a part in the City's overall flood control strategy. The Goshen Basin expansion – increasing storage volume by re-grading the side slopes of the basin – is designed to increase the limited floodwater storage capacity on the west side of the City, improving flood protection for residential and industrial areas surrounding this location and allowing for additional flood layoff from North Mill Creek. The Oakes Basin expansion will help to reduce peak flow conditions along Packwood and Mill Creek, minimizing overtopping of the creek banks and overland flooding. The Oakes Basin expansion will also provide additional lay-off capacity within creeks, thus accommodating greater urban runoff during large storm events. The construction of Peoples Basin will help remove peak flows high up on the Kaweah River in order to benefit multiple creeks (Mill Creek and Packwood Creek) that flow through the City and addressing high flow conditions hours before they reach the City's boundaries. Flood water diverted into these basins will be returned to local watercourses using pump back stations or by gravity. The proposed Goshen and Oakes Basin improvements will include pump back stations and the Peoples Basin is expected to be a gravity return. Pump back stations will allow the basins to be evacuated between storms, reducing flood damage caused by back-to-back storms events.

Collectively, these projects will help meet the project goal, which is to reduce some of the City's current flooding issues. The combination of localized flood control strategies will allow the City to better manage runoff from storm events with 25- to 100-yr return periods, reducing the potential for flood damage within the City.

SECTION 3 EVALUATION OF PROJECT IMPACTS

3.1 On Floodwaters

The proposed Project will enhance flood hazard reduction goals by expanding an existing storm water layoff capacity within the City (Goshen Basin), expanding an existing flood layoff upstream of the City (Oakes Basin), and converting an existing recharge basin into a flood layoff basin upstream of the City (Peoples Basin). The combined projects will allow the City to better manage flooding caused by storm water runoff within the City and allow for floodwater to be diverted prior to reaching the City.

For the 2009 Federal Emergency Management Agency Flood Insurance Study (FIS) FEMA hired Northwest Hydraulic Consultants (NHC) to perform a detailed flood study for the entire City. This detailed flood study mapped the anticipated base flood elevations (BFE) and established flood plan boundaries for use in the FIS. This detailed flood study is currently the most detailed and up to date hydrology and hydraulic study of the Visalia area. As part of the Plan, NHC was subcontracted to rerun portions of the City's FIS model with and without the proposed improvements.

The detailed flood study by NHC was based off a MIKEFLOOD model that was developed as part of the FIS. The MIKEFLOOD model combined 1-D (MIKE11) and 2-D (MIKE21) hydrodynamic models. The MIKE11 model was used to study flow within the network of rivers, streams, creeks, and ditches that run throughout the City. The MIKE21 component of the model was used to study overland flooding that resulted from the overtopping of rivers, streams, creeks, and ditches in and around the City. The Mike11 and Mike21 model was developed from surveyed cross-sections of the floodwater conveyance network and a combination of LiDAR and orthophotography, respectively.

For this Plan, portions of the NHC model where decoupled and rerun for existing and proposed conditions. The MIKE11 model was decoupled from the larger MIKEFLOOD model. Only the MIKE11 portion of the model was used for the analysis in the Plan. This was done largely to minimize the somewhat subjective processes of defining flood hazard zones and calculating their average flood elevation. The original 2-D analysis produced a patchy network of flood depths distributed throughout the City. This network of flood depths was grouped into sections of land that share similar flooding characteristics. The flood depths within these sections of land were averaged to come up with a final flood depth for that section. The process of selecting similar flooding characteristics and calculating an average base flood elevation is a time intensive and somewhat subjective process. For that reason, only the MIKE11 part of the model was used in the Plan. The MIKE11 model was used to evaluate the water surface elevations for existing and proposed improvements within the floodwater conveyance network. By analyzing water surface elevations within the channels and evaluating the location of where the channel could be overtopped, the MIKE11 model worked as a proxy for the larger MIKEFLOOD overland flooding model.

The Mike11 model was run as an unsteady flow model for the 10-, 50-, and 100-year return period events. Existing condition hydrographs were taken from the 2009 FIS. For proposed conditions, the existing hydrographs where adjusted to reflect the reduction in flow in the main channel due to diversions into Goshen, Oakes, and Peoples Basins. A summary of the proposed projects, beginning at the downstream end, and the results of the Plan analysis are as follows:

3.1.1 Goshen Basin

The existing Goshen Basin is a 143 acre-feet storm layoff basin located on the northwestern edge of the City (see Exhibit 2). This basin is located in a largely industrial area with an area of residential housing to the west and northwest. The City operates the Goshen Basin as a storm water drainage facility to collect storm waters from developed areas on the west side of Visalia. The basin is a terminal point for a large 48 inch storm main that runs within the Goshen Avenue right-of-way. The existing basin also has a 30 inch inflow pipeline connection from North Mill Creek. Mill Creek splits into a north and south branch within the City and historically the north branch is used as a floodwater layoff facility by Kaweah Delta Water Control District (KDWCD). The existing 30 inch inflow pipeline that links North Mill Creek to the Basin will be modified and connected to a lift station allowing for reverse flow from the basin back to North Mill Creek. The proposed Goshen improvements will allow the basin to be fully evacuated within 14 days, allowing the basin to be utilized in back-to-back storm events. The proposed expansion will also add an additional 17 acre-feet of layoff capacity to the basin.

NHC analyzed the benefits of the Goshen Basin improvements by evaluating the effect the basin has on North Mill Creek. Within North Mill Creek, Goshen Basin improvements would reduce the water surface elevation during the 50-year and 100-year event by less than 0.5 feet and the majority of WSEL reduction would occur near the basin inlet. The proposed improvements are capable of capturing the entire 10-year event and would reduce the total volume of water being discharged west beyond Highway 99 by over 30% during the 50-year event, and 5% during the 100-year event.

3.1.2 Oakes Basin

This existing Oakes basin is capable of holding approximately 290 acre-feet of water and is located upstream of the City between Road 152 and 158, at the bifurcation of the Kaweah River into Mill and Packwood Creeks (see Exhibit 3). The City and KDWCD developed this basin site as a layoff basin in an area that could address flood flows on two of the creek systems that flow through significant portions of the City; however, the existing facility only provides a portion of the protection needed along these creeks. The proposed Oakes Basin expansion will add an additional 135 acre-feet of storm water layoff capacity.

NHC evaluated the benefits of expanding Oakes Basin by analyzing the effect that floodwater layoff would have on Packwood Creek. Although not directly evaluated in the NHC report, Oakes basin would have a similar positive effect on Mill Creek as well. NHC calculated that the proposed basin improvements would reduce the peak water levels within Packwood Creek by 0.8 feet, 0.7 feet, and 0.5 feet for the 10 year, 50 year, and 100 year storm events, respectively. Reducing peak water levels by 0.5 ft during a 100 year storm event would reduce overtopping from five locations along the existing channel to only one location, significantly reducing overland flooding along Packwood Creek.

3.1.3 Peoples Basin

The proposed Peoples Basin conversion project (see Exhibit 4) would expand an existing recharge basin into a floodwater layoff/recharge basin and increase transitory storage on the Kaweah River system so that damage within the City could be reduced through lowering of peak flows to Mill Creek and Packwood Creek. The project includes the construction of a single celled basin with a capacity of 175 acre-feet. The basin would receive water from the Kaweah River via a proposed turnout located upstream of a check structure for the Peoples Consolidated Ditch Company.

NHC analyzed the benefits of Peoples Basin by evaluating the effect floodwater layoff basin would have on the Kaweah River. The Kaweah River is located upstream of the City and ultimately terminates into Mill Creek and Packwood Creek at the location of Oakes Basin. Due to the high flow rates anticipated on the Kaweah River, the proposed project does not significantly reduce overland flooding along the Kaweah River near the project site and upstream of the city limit; however, the proposed project would reduce peak flows along the Kaweah River by approximately 100 cubic feet per second. Ultimately, this reduction in flow would result in a flow reduction along Packwood Creek and Mill Creek. As described previously in NHC's Oakes Basin analysis, a peak flow reduction of 100 cubic feet per second is shown to have a significant impact on reducing overland flooding along Packwood Creek (a reduction in flooding along Mill Creek is also anticipated).

3.2 On Structural Integrity of Affected Levees

The Project will not negatively impact levees because there are no federal levees or non-federal levees near the three project sites.

3.3 On Diversion Facilities

Although there are existing diversion facilities within the immediate vicinity of each basin site none of these facilities would be negatively impacted by the Project. Most of the Project activities will occur on disturbed lands adjacent to existing watercourses and not within a channel. Additional details about impacts are discussed in the following subsections.

3.3.1 Goshen Basin

Goshen Basin improvements include a pump out station to allow the basin to be emptied back into North Mill Creek. Water from the pump station will be returned to North Mill Creek via the original diversion facilities. The pump out station construction will convert Goshen Basin from retention to a detention facility, greatly improving Goshen Basin's ability to handle back-to-back storm events. Discharges from Goshen Basin into North Mill Creek will be managed by the City and will occur between storm events when flows in North Mill Creek are low. All other existing inlet and/or diversion facilities into Goshen Basin are anticipated to remain unaffected by the proposed improvements.

3.3.2 Oakes Basin

Oakes Basin has an existing diversion structure located at the bifurcation of the Kaweah River into Mill Creek and Packwood Creek. The proposed Oakes Basin expansion includes improving an existing diversion structure so that water can be both diverted and returned to the channel through a single structure. Diversion structure improvements include increasing diversion capacity and adding a pump back station. Similar to Goshen Basin, the addition of a pump back station will allow the facility to operate as a detention facility instead of a retention facility, greatly increasing the basins ability to respond to back-to-back storm events.

3.3.3 Peoples Basin

The Peoples Basin project proposes to construct a 48" RCP turnout structure upstream of an existing check structure located in the Kaweah River. The proposed structure will allow for the diversion of floodwaters into the proposed basin. The turnout structure will have no effect on any existing diversion facilities. Water from this basin will be returned to the Kaweah River via a 24" diameter pipe with manually operated control gate.

3.4 On Customary Agricultural Husbandry Practices

The proposed Project will not negatively impact customary agricultural husbandry practices. The flood layoff basins proposed for expansion are not in the vicinity of dairies, chicken ranches, or other animal husbandry facilities. Additionally, animal husbandry facilities downstream of the basins to be expanded will receive flood protected benefits from the Project.

3.5 On Timber Extraction Operations

The Project will not impact timber extraction operations as there are no timber extraction operations in the vicinity of the Project.

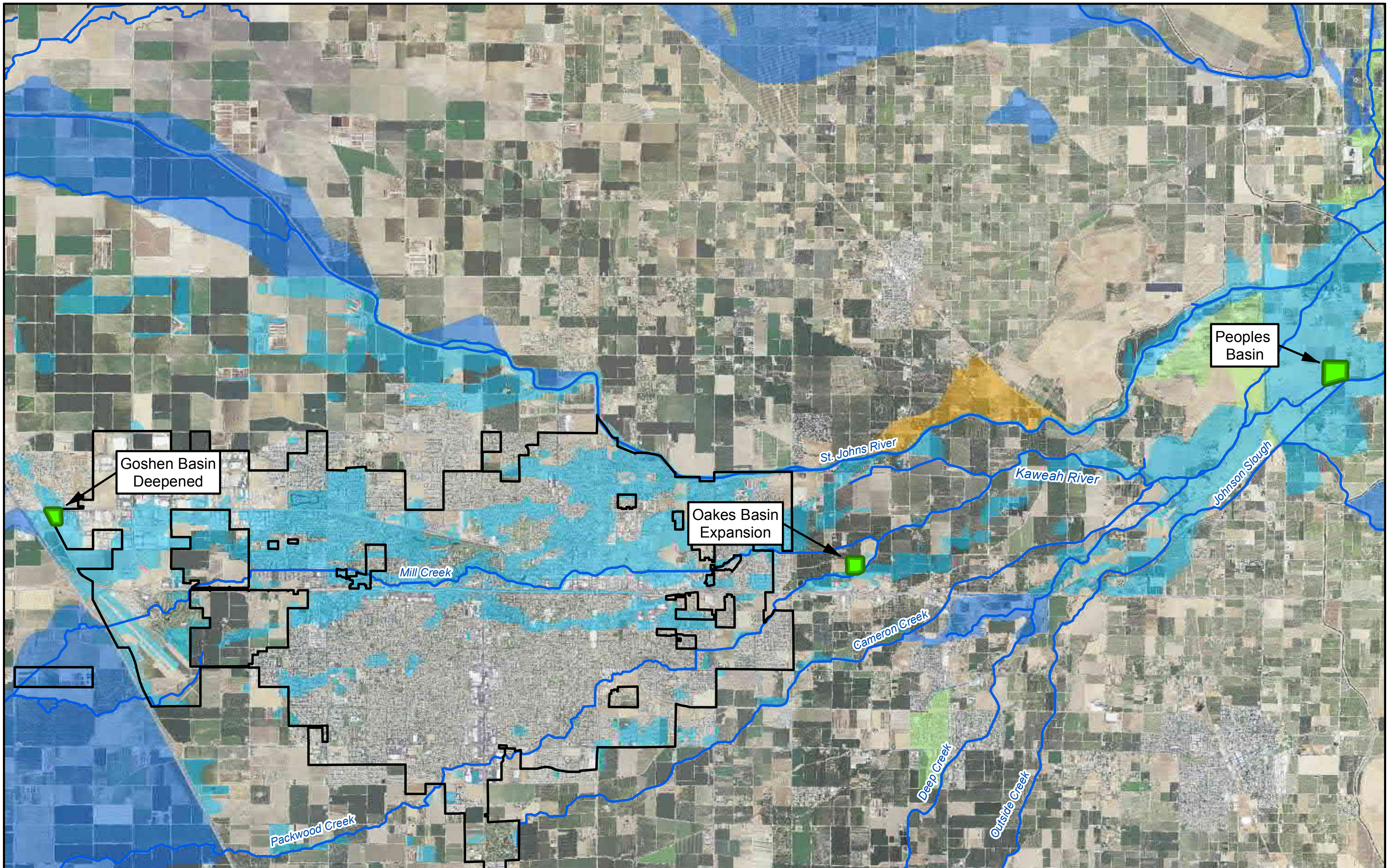
3.6 On Maintenance of Any Facilities Proposed to be Altered or Constructed

This project involves the expansion/conversion of three existing basins. All improved or newly constructed facilities identified in this report will be owned by the City. The City is responsible for the long-term maintenance and management of the Goshen Basin, expanded sections of Oaks Basin, and Peoples Basin. KDWCD will be responsible for long-term maintenance and management of the existing portions of Oakes Basin. Through maintenance and monitoring, the City and KDWCD will ensure that the facilities continue to operate as they were originally designed, minimizing any potential impact to adjacent land owners.

SECTION 4 CONCULSION

4.1 Conclusion

The construction, operation, and maintenance of the City Flood Control Improvement Project is not anticipated to have any adverse impacts on the existing adjoining property owners and land use practices. The proposed projects will enhance the City's ability to manage flooding by allowing the City to divert and store floodwaters upstream of the City, minimizing overtopping of Mill Creek and Packwood Creek. By reducing overtopping, the proposed Oakes Basin expansion and Peoples Basin conversion are anticipated to also improve overland flooding conditions for the existing adjoining property owners that are located upstream of the City. The proposed Goshen Basin expansion will increase the amount of floodwater storage within the City. This additional storage will allow for more urban storm water runoff to be diverted away from the residential and industrial areas located adjacent to the project, improving flood hazard conditions on the west side of the City. Goshen Basin will also reduce the peak discharges from North Mill Creek which will improve existing overland flooding conditions for the adjoining property owners located downstream of the project site. The proposed projects together will not only reduce flooding within the City, but will also improve existing flood conditions for existing landowners located upstream and downstream of the City.



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CONSULTING GROUP
An Employee Owned Company

130 N. Garden Street
Visalia, CA 93291
(559) 636-1166

Legend

- Proposed Projects
- Visalia City Limits
- Stream/River

FEMA - 100 yr Flood Zones

- A - No base flood elevations determined
- AE - Base flood Elevations determined
- AH - Flood depths of 1 to 3 ft (ponding) with Elevations
- AO - Flood depths of 1 to 3 ft (allvuvial fan/sheet flow)

*2012 NAIP, Aerial Imagery

Plan To Minimize Impacts Report

Project Locations

EXHIBIT 1

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Legend

Existing Goshen Basin To Be Deepened

*2012 NAIP, Aerial Imagery

Plan To Minimize Impacts Report

Goshen Basin Improvements

EXHIBIT 2

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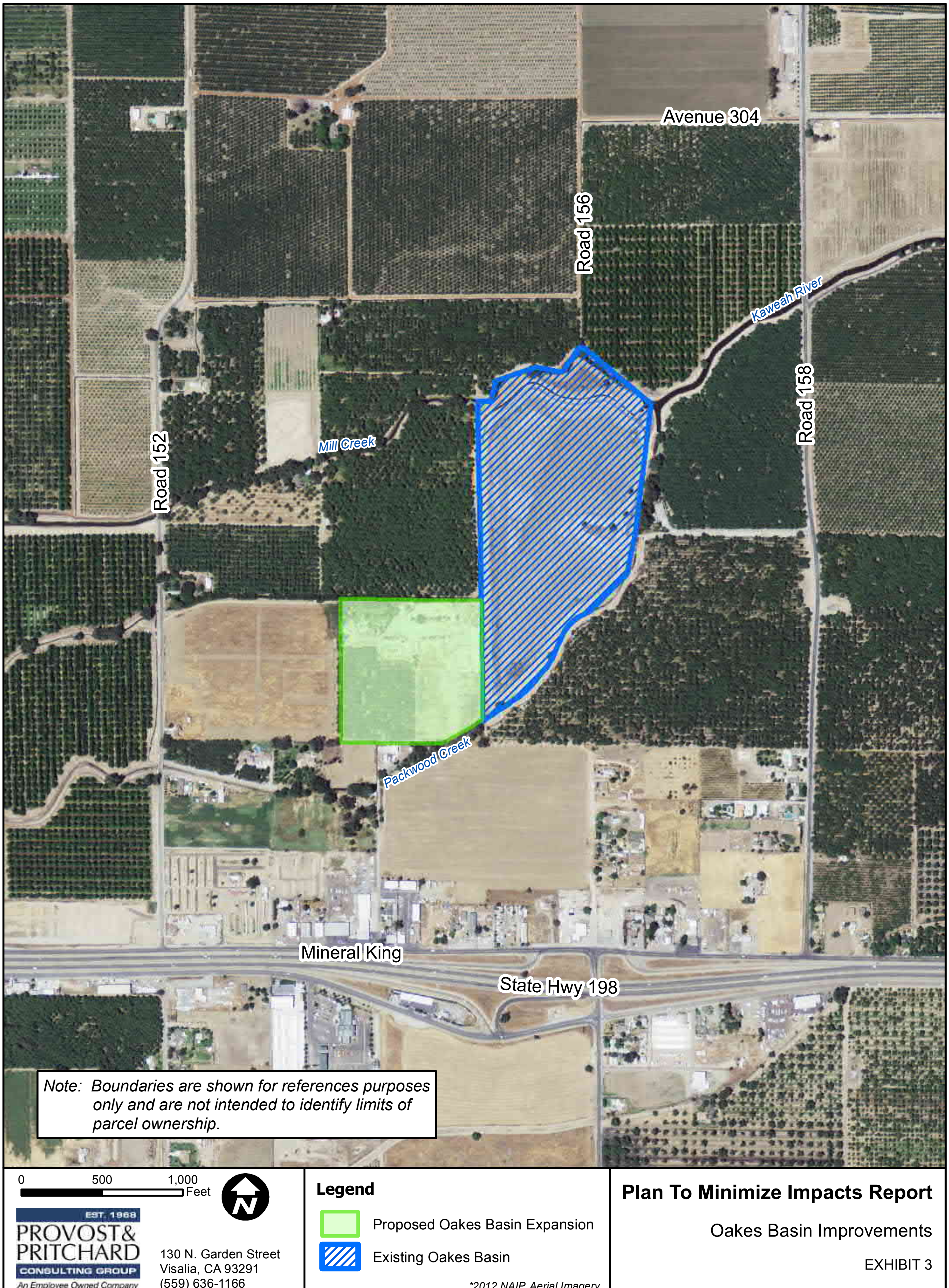

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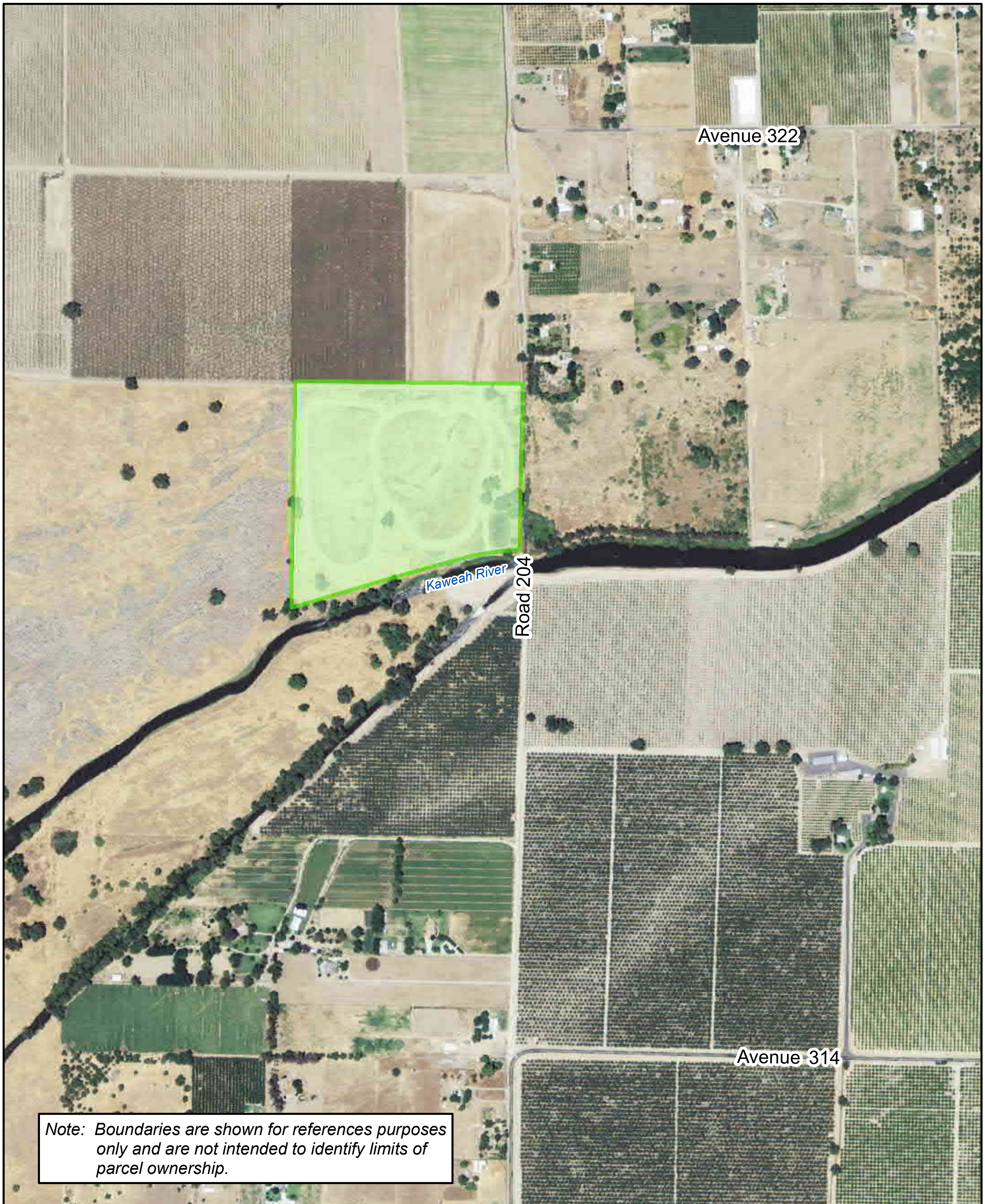
Plan To Minimize Impacts Report

Oakes Basin Improvements

EXHIBIT 3



0 500 1,000 Feet

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Legend

Proposed Peoples Basin

2012 NAIP, Aerial Imagery

Plan To Minimize Impacts Report

Peoples Basin

EXHIBIT 4

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LOWER KAWEAH RIVER
& MILL CREEK SYSTEM
FLOOD CONTROL IMPROVEMENT PROJECT

HYDRAULIC AND HYDROLOGIC STUDY

Prepared for:

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PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company

Chad Wegley, P.E.

30 July 2015

NHC Ref. No. 500117

nhc
northwest hydraulic consultants
water resource specialists

LOWER KAWEAH RIVER & MILL CREEK SYSTEM
FLOOD CONTROL IMPROVEMENT PROJECT

HYDRAULIC AND HYDROLOGIC STUDY

Prepared for:

Provost & Pritchard Consulting Group

Visalia, CA

Prepared by:

Northwest Hydraulic Consultants Inc.

West Sacramento, CA

30 July 2015

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1.0 Introduction

Northwest Hydraulic Consultants (NHC) was contracted by Provost and Pritchard Consulting Group (Provost) to evaluate the potential hydraulic impacts of proposed layoff basins along the Lower Kaweah River system near Visalia, California. The proposed layoff basins are being installed to capture excess stormwater and provide groundwater recharge. The layoff basins will also help reduce flood risk by reducing flow in stream channels downstream of the basins thereby reducing the likelihood for channel overtopping. The objective of the NHC study is to validate the improvements in flood risk.

NHC utilized the MIKEFLOOD model developed as part of the City of Visalia Flood Insurance Study (FIS) (NHC, 2007) to evaluate the hydraulic impacts of the layoff basins. Section 2.0 of this memorandum provides a brief summary of the NHC (2007) FIS study. Section 3.0 shows the proposed basin locations and hydraulic characteristics. Section 4.0 outlines the project methodology including model development, study hydrology, and model scenarios. Section 5.0 provides results of the modeling effort while Section 6.0 provides an overall summary of the project.

2.0 Previous Work

NHC (2007) completed a detailed hydraulic study of flood conveyance through the City of Visalia as part of the FEMA's FIS update. NHC (2007) utilized the MIKEFLOOD software. MIKEFLOOD couples 1-D (MIKE11) and 2-D (MIKE21) hydrodynamic models. The MIKE11 component of the model was used to simulate flow in the distributary network of streams. The MIKE21 component of the model simulated overland flow resulting from the overtopping of stream channels. The MIKEFLOOD model utilized flood hydrographs developed by the U.S. Army Corps of Engineers at the Kaweah River downstream of Terminus Dam, Dry Creek at the Kaweah River confluence, Yokohl and Merten creeks for the 10-year, 50-year, 100-year, and 500-year reoccurrence events (USACE 1996, 2005). Figure 3.1 shows the extents of the MIKE11 model and inflow locations.

The MIKEFLOOD model was developed from surveyed cross-sections for the MIKE11 network and a combination of LiDAR and orthophotography for the MIKE21 component. Merrick and Company collected topograhic data for the development of the NHC (2007) hydraulic models between November of 2004 and June of 2005. The survey included approximately 375 channel cross-sections and 235 hydraulic structures in 17 separate channels. The topographic data was collected in California State Plan Zone IV projection with a NAD 1983 feet horizontal datum and NGVD 1929 feet vertical datum. The NHC (2007) MIKEFLOOD models are georeferenced to the topography and use these same datums. Output from the NHC (2007) models is therefore also relative to these same datums.

3.0 Proposed Basins

Provost (2014) provided preliminary design information for the three proposed basins. Table 3.1 presents the key features of the proposed basins. Goshen Basin is located at W Goshen Ave and Camp Dr and has an existing capacity of 143AF. The proposed basin is a 17AF expansion through regrading of the existing Goshen Basin. The proposed Oakes Basin is located to the west of the existing Oakes Basin (290AF) and has a storage capacity of about 135AF. The proposed Peoples Basin is a new detention basin with a storage capacity of 175AF. It is located on the north side of the Lower Kaweah River and 10 miles east of Visalia. Figure 3-1 shows the locations of the proposed basins.

Table 3.1 Key Features of the Proposed Basins

	Peoples Basin	*Oakes Basin*	*Goshen Basin*
Approximate Storage Volume (AF)	175	135 (additional)	17 (additional)
Inlet Pipe Diameter (in)	48	48	30
Maximum Inlet Flow Rate (cfs)	100	100	24.5

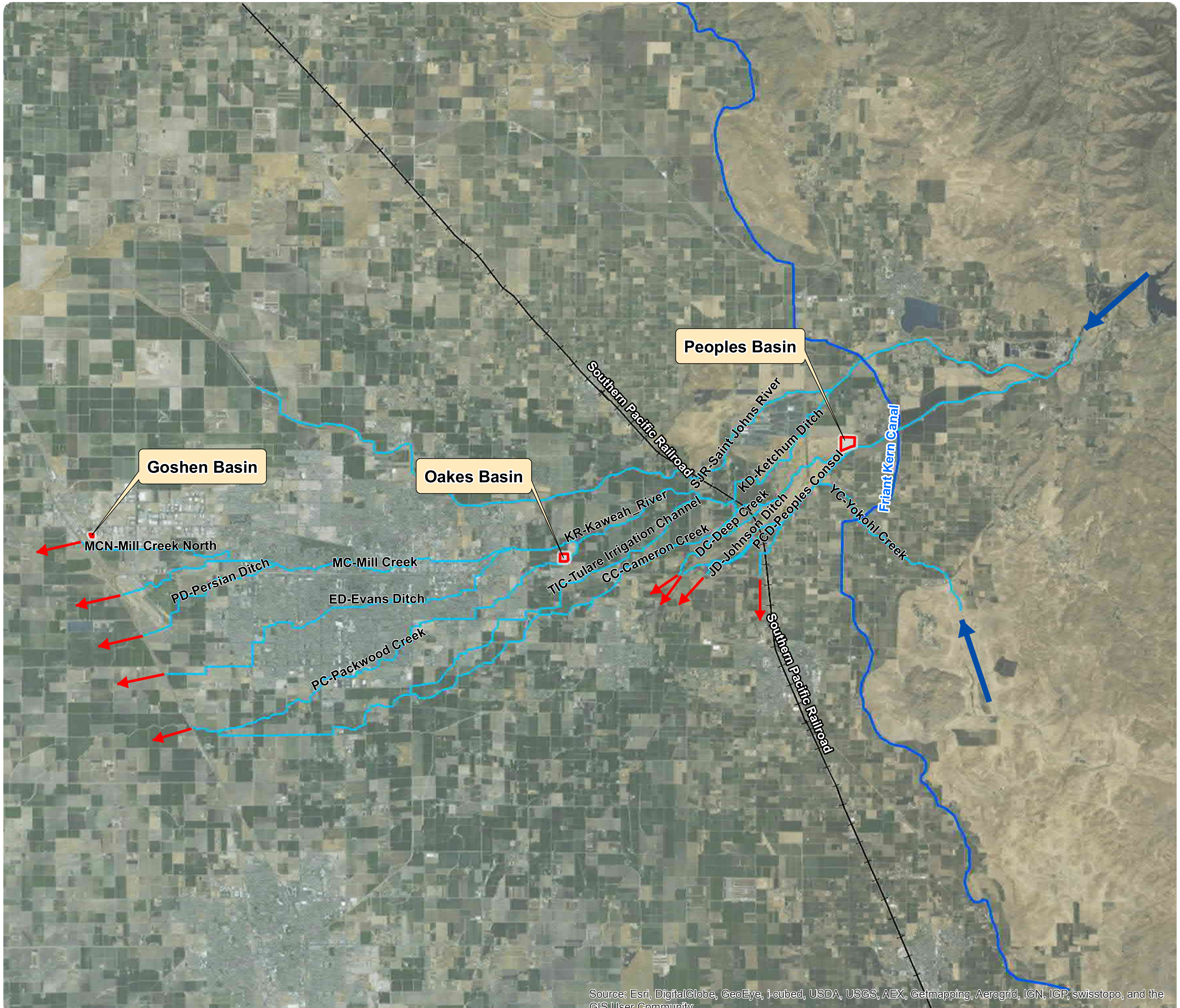
City of Visalia-Flood Control Improvement Project

Figure 3-1
Basin Locations

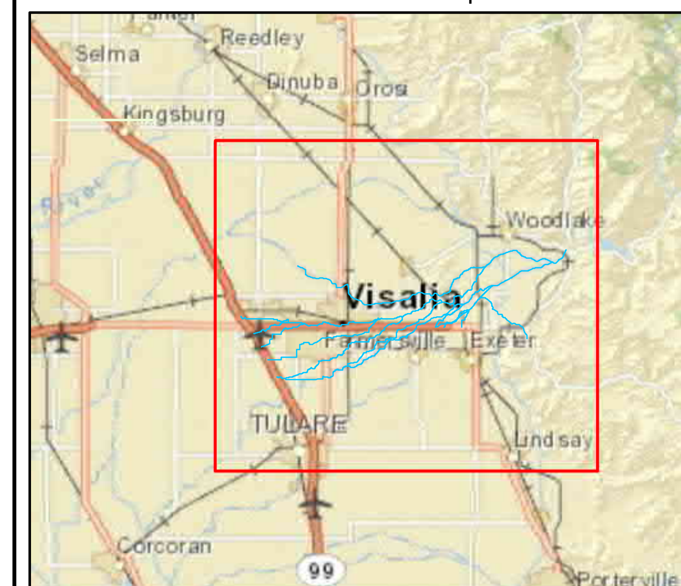
Scale - 1:168,000 | 1 inch = 14,000 feet

0 4,000 8,000 16,000 24,000 Feet

CA State Plane, Zone VI	horz. datum: NAD 83	horz. units: feet
northwest hydraulic consultants	project no. 500117	July 2014



Reference Map



Legend

- FIS MIKE 11 Network
- FIS MIKE 11 Inflow Locations
- FIS MIKE 11 Outflow Locations
- Proposed Basins

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4.0 METHODOLOGY

The potential effects of the proposed layoff basins were evaluated using a comparative analysis of proposed to existing conditions. The MIKE11 component of the NHC (2007) model discussed in Section 2 was used as the base model for this study. Individual channel reaches downstream of each proposed basin were parsed from the NHC (2007) MIKE 11 model and modeled separately for both existing and proposed conditions. The upstream extent of each model reach was located at the approximate diversion for the proposed basins. The models were run as unsteady flow models for the 10-, 50-, and 100-year return period events. Existing condition hydrographs were taken from the NHC (2007) MIKE11 model output at the upstream extent of each model location. The existing condition hydrographs were adjusted to reflect the loss of flow to the individual basins to model the proposed conditions. Model geometry was kept consistent between existing and proposed conditions.

4.1 Model Development

The Goshen Mill Creek North (MCN) model was used to evaluate the effects of the Goshen Basin on the Mill Creek North Reach. The model starts immediately upstream of the basin and consists of 0.4 miles of Mill Creek North from where it branches out from the Mill Creek to Highway 99. A total of 5 cross-sections define the Mill Creek North model network. The model domain includes 1 culvert which is located about 130 ft from Camp Drive along Mill Creek North. Figure 4.1.1 shows the Goshen MCN model extents.

The Oakes Packwood Creek (PC) model was used to evaluate the effects of the proposed expanded Oakes Basin on Packwood Creek. The Oakes PC model includes a 12 mile reach of Packwood Creek starting just upstream of the proposed Oakes Basin up to Highway 99. A total of 76 cross-sections defines Packwood Creek model network. The model domain includes 21 structures; 15 bridges, 4 culverts and 2 weirs. Figure 4.1.2 shows the Oakes PC model extents.

The Peoples Kaweah River (KR) model was used to evaluate the effects of Peoples Basin on both the Kaweah River and Deep Creek tributary. For the Peoples KR model the main Kaweah River started immediately upstream of the proposed Peoples Basin up to the Southern Pacific Railroad Bridge and is about 3.2 miles in length. A total of 20 cross-sections defined the river and include 6 structures; 3 bridges and 3 weirs. Deep Creek tributary branched off from the main Kaweah River and also extends up to the Southern Pacific Railroad Bridge. This river network is about 0.4 miles in length and is defined by a total of 9 cross-sections. It also includes 4 structures; 2 bridges and 2 weirs. Figure 4.1.3 shows the Peoples KR model extents.

A Manning's co-efficient of 0.05 was used for all channel cross-sections. This value is consistent with the NHC (2007) study. The simulation period for this study was 4.5 days of the peak flood for all three models. MIKE11 timesteps for the simulations varied between 0.1 to 0.5 seconds. Constant water surface elevations consistent with the NHC (2007) MIKE11 model were specified as downstream boundary conditions for the Goshen MCN model, Oakes PC model. The downstream boundary condition for the Peoples KR model was a stage-discharge relationship output from the NHC (2007) MIKE11 model.

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Figure 4.1.1
Goshen Basin: Mill Creek North

Scale - 1:18,000 1 inch = 1,500 feet

0 750 1,500 3,000 Feet

CA State Plane, Zone VI	horz. datum: NAD 83	horz. units: feet
northwest hydraulic consultants	project no. 500117	July 2014

Reference Map

Legend

- FIS MIKE 11 Network
- Inflow into Goshen MCN Model
- Goshen Basin
- Goshen MCN Model Extent

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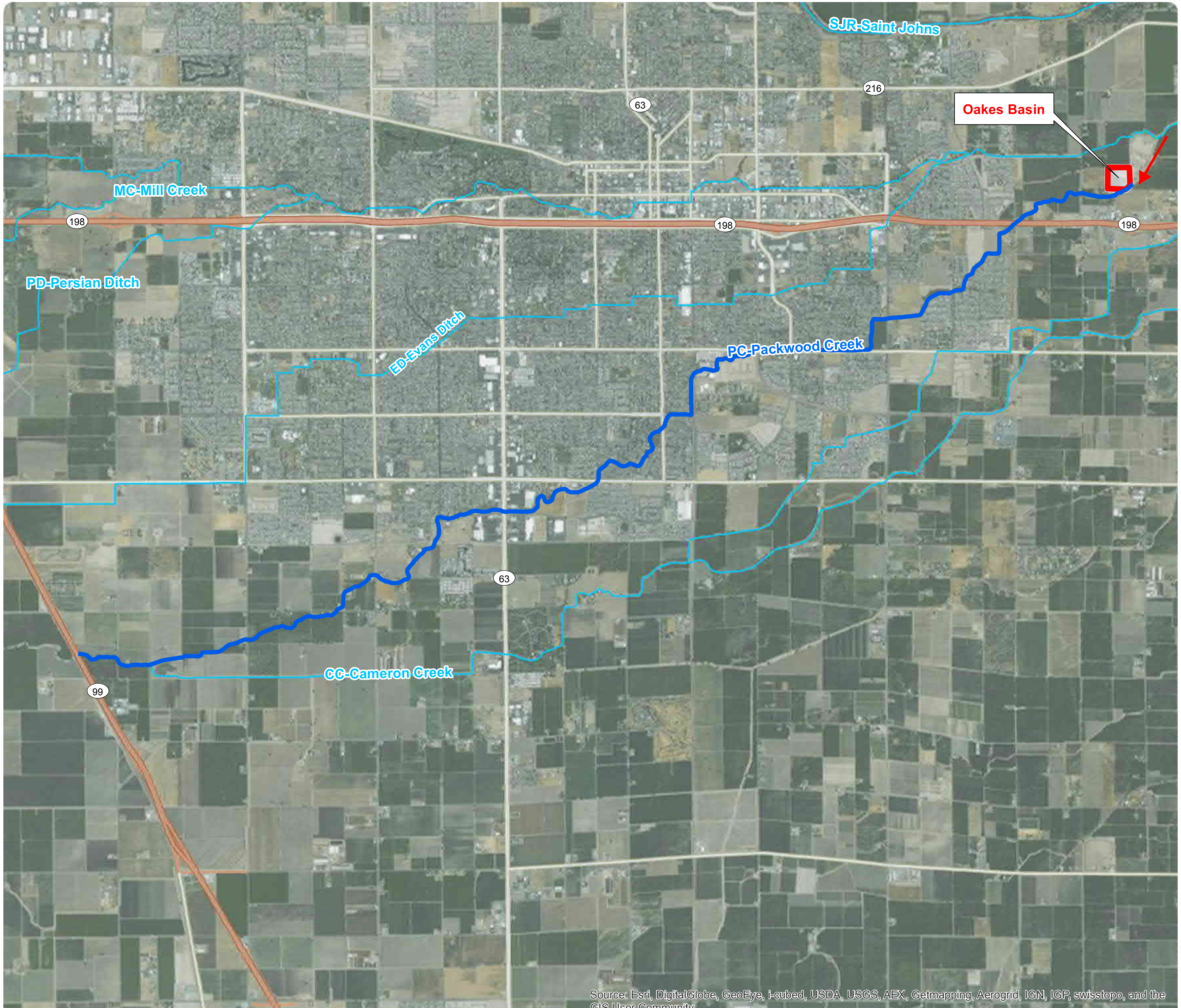
Figure 4.1.2
Oakes Basin: Packwood Creek

Scale - 1:60,000 | 1 inch = 5,000 feet

0 2,500 5,000 10,000 Feet

CA State Plane, Zone VI	horz. datum: NAD 83	horz. units: feet
northwest hydraulic consultants	project no. 500117	May 2014



Reference Map

Legend

- FIS MIKE 11 Network
- Inflow into Oakes PC Model
- Oakes Basin
- Oakes PC Model Extent

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Figure 4.1.3
Peoples Basin: Kaweah River

Scale - 1:36,000   1 inch = 3,000 feet

0   1,500   3,000   6,000 Feet

CA State Plane, Zone VI	horz. datum: NAD 83	horz. units: feet
northwest hydraulic consultants	project no. 500117	July 2014

Reference Map

Legend

- FIS MIKE 11 Network
- Inflow into Peoples KR Model
- Peoples Basin
- Peoples KR Model Extent

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4.2 Hydrology

The existing condition inflow hydrographs for the three models were extracted from the FIS models for 10-, 50- and 100-yr return periods at the upstream cross-section of the individual basin models. The proposed condition hydrographs were modified to incorporate the reduction in flow downstream of the basins due to the new or modified basins. The proposed condition hydrographs reflect the net effects of any new or modified lay off basins to best quantify the reductions in flood stage provided by the new or modified basins. The modified hydrographs assumed a constant inflow into the basins equivalent to the maximum inflow rate. The new basins were assumed to be empty at the start of the storm event, although existing basins were assumed to be at capacity to fully capture the net effects of the modified and expanded basins. The flow hydrograph downstream of the basin was therefore reduced by the maximum inflow rate for the duration required to fill the empty basin.

Figure 4.2.1 shows the existing and proposed inflow hydrographs for the Goshen MCN Model. The maximum inflow for Goshen Basin is 24.5 cfs. Given this flow rate, it would take approximately 8 hours to fill the 17 AF basin. The existing condition hydrograph shows two peaks occurring during the 100-year hydrograph at hours 80 and 97, a single peak flow during hour 79 and hour 81 of the 50 year and 10 year event respectively. The proposed hydrographs removed 24.5 cfs between the hours of 90 and 100 for the 100-yr event and hours 72 and 82 for the 50-yr event. During the 10-year event, the total volume of water passing through Mill Creek is only about 4 AF, with a peak flow rate of less than 24.5 cfs. The basin is capable of capturing all the flow during a 10-year and more frequent events.

Figure 4.2.2 shows the existing and proposed inflow hydrographs for the Oakes PC Model. The maximum inflow into the proposed Oakes Basin expansion is 100cfs. The expanded Oakes Basin with a capacity of 135AF would take approximately 15 hours to fill the basin. The existing condition hydrograph shows two peaks occurring during the 100-year hydrograph at hours 73 and 90, a single peak flow during hour 73 of the 50 year and 10 year event respectively. The proposed hydrographs removed 100cfs between hours 82 and 97 for the 100-yr event, hours 65 and 80 for the 50-yr event and hours 66 and 81 for the 10-yr event.

Figure 4.2.3 shows the existing and proposed inflow hydrographs for the Peoples KR Model. The maximum inflow into the proposed Peoples Basin is 100cfs. The proposed Peoples Basin with a capacity of 175AF would take approximately 20 hours to fill the basin. The existing condition hydrograph shows two peaks occurring during the 100-year hydrograph at hours 73 and 88, a single peak flow during hour 70 of the 50 year and 10 year event respectively. The proposed hydrographs removed 100cfs between hours 78 and 98 for the 100-yr event and hours 60 and 80 for the 50-yr and 10-yr event.

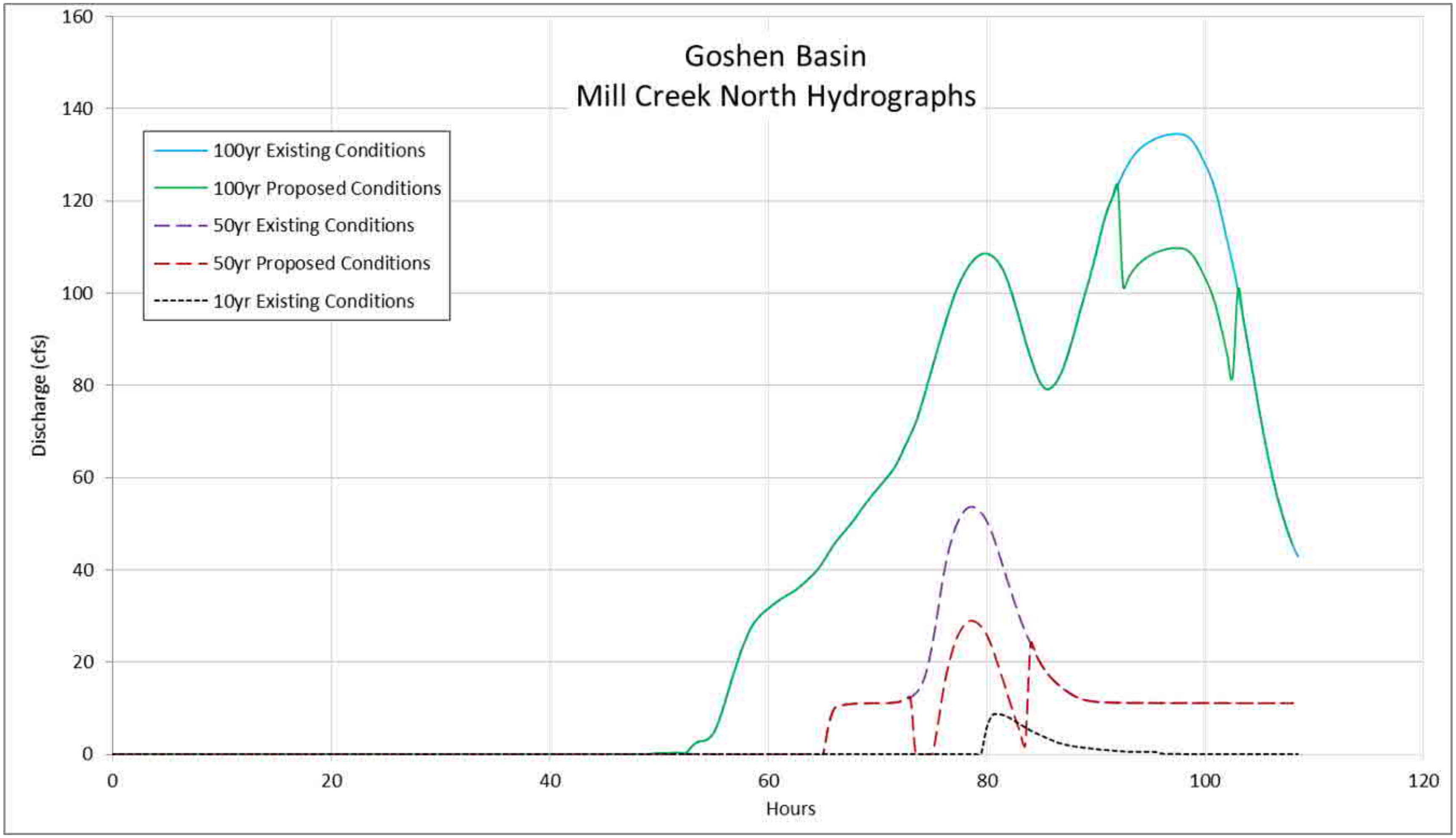

Figure 4.2.1 Existing Vs Proposed Hydrographs used in the Goshen MCN MIKE11 Model

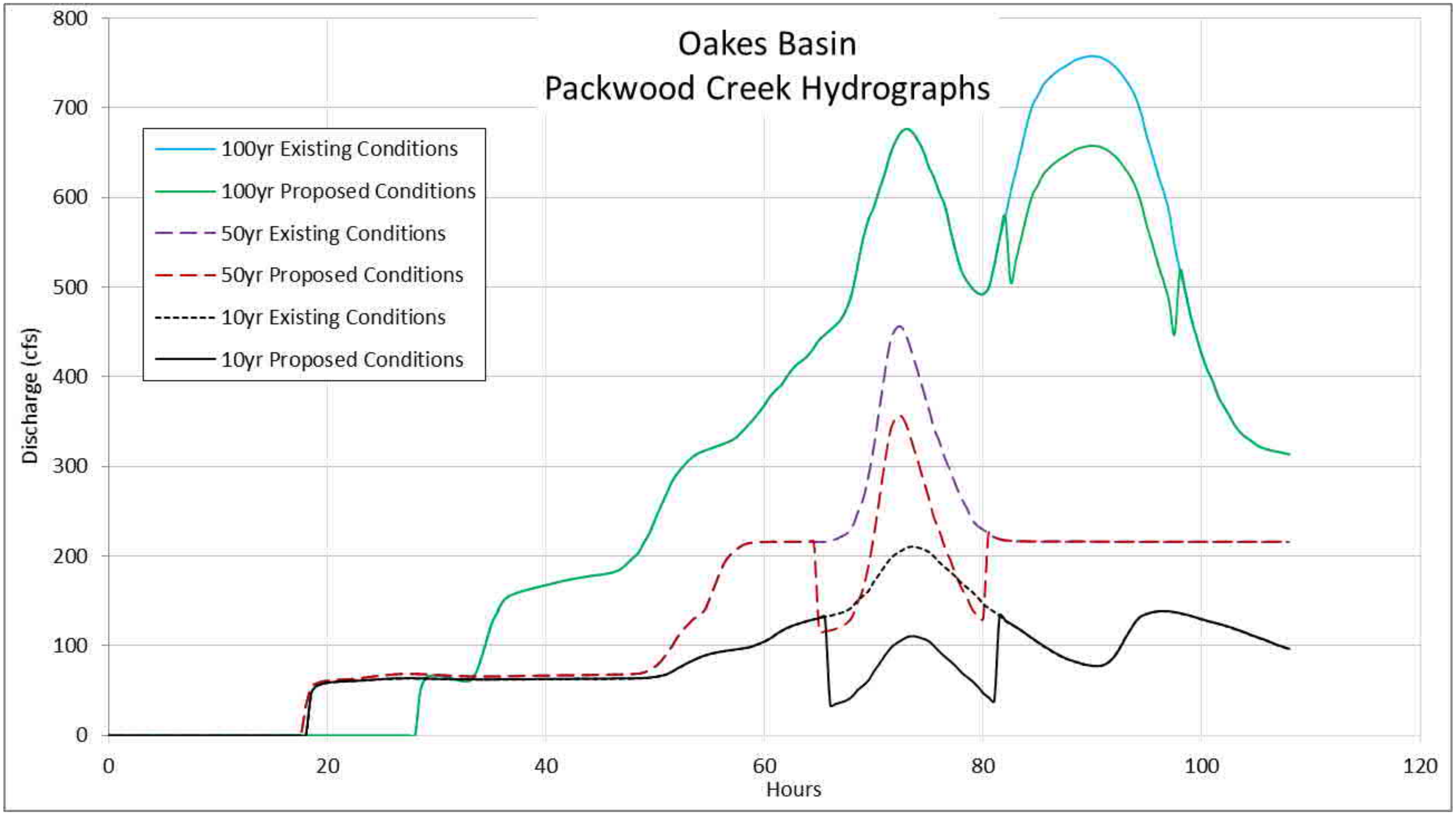

Figure 4.2.2 Existing Vs Proposed Hydrographs used in the Oakes PC MIKE11 Model

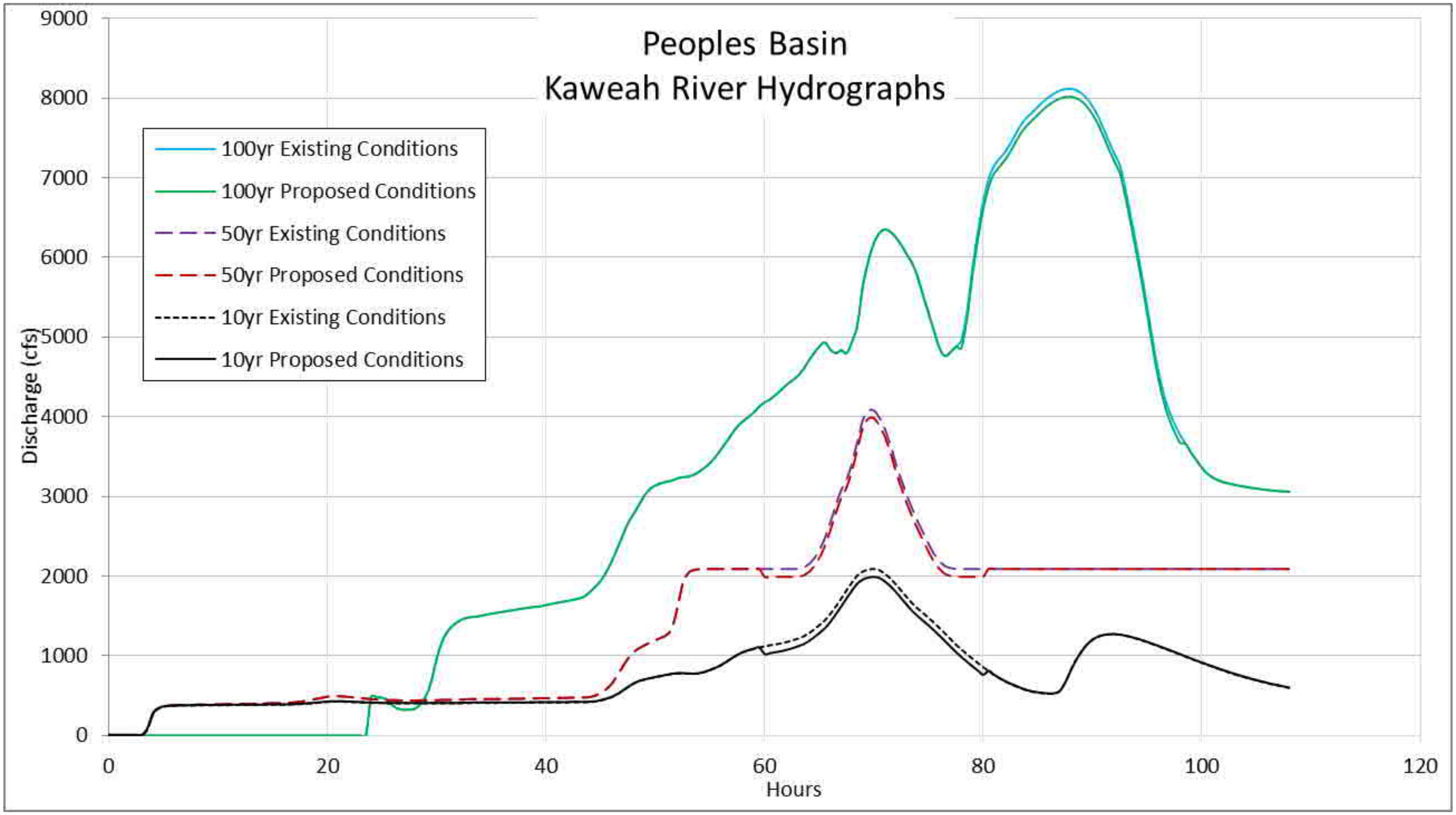

Figure 4.2.3 Existing Vs Proposed Hydrographs used in the Peoples KR MIKE11 Model

5. MODEL RESULTS

Peak in-channel water levels for the existing and proposed models were compared to top of bank elevations from the FIS MIKE11 model (NHC 2007). Locations where the water levels exceed the top of bank elevations are indicative of locations where overbank flooding would occur. Reduction in peak water levels due to the presence of the basins reduces the likelihood for overtopping and flooding during extreme events. The following sections provide results and discussion for each of the three models.

5.1 Goshen Basin

Figures 5.1.1a and 5.1.1b compare the peak water surface elevations for the 50 year storm to the top of bank elevations for the left bank and right bank of Mill Creek North, respectively. The channel has about 5 feet of freeboard at the upstream of the channel with high berms on both the left and right bank at the downstream end of the model. The presence of the basin reduces the water surface elevation during the 50-yr and 100-yr event by less than 0.5 ft. The channel shows reduction in water levels close to the proposed basins. Both existing and proposed models show backwater effects from the constant water level used as the downstream boundary condition. This boundary condition is consistent with the effective FIS (NHC, 2007). The basin, however does have the capacity to capture the entire 10-year event, and reduces the total volume of water being discharged through Highway 99 (downstream model boundary) by over 30% during the 50-year event, and 5% during the 100-year event.

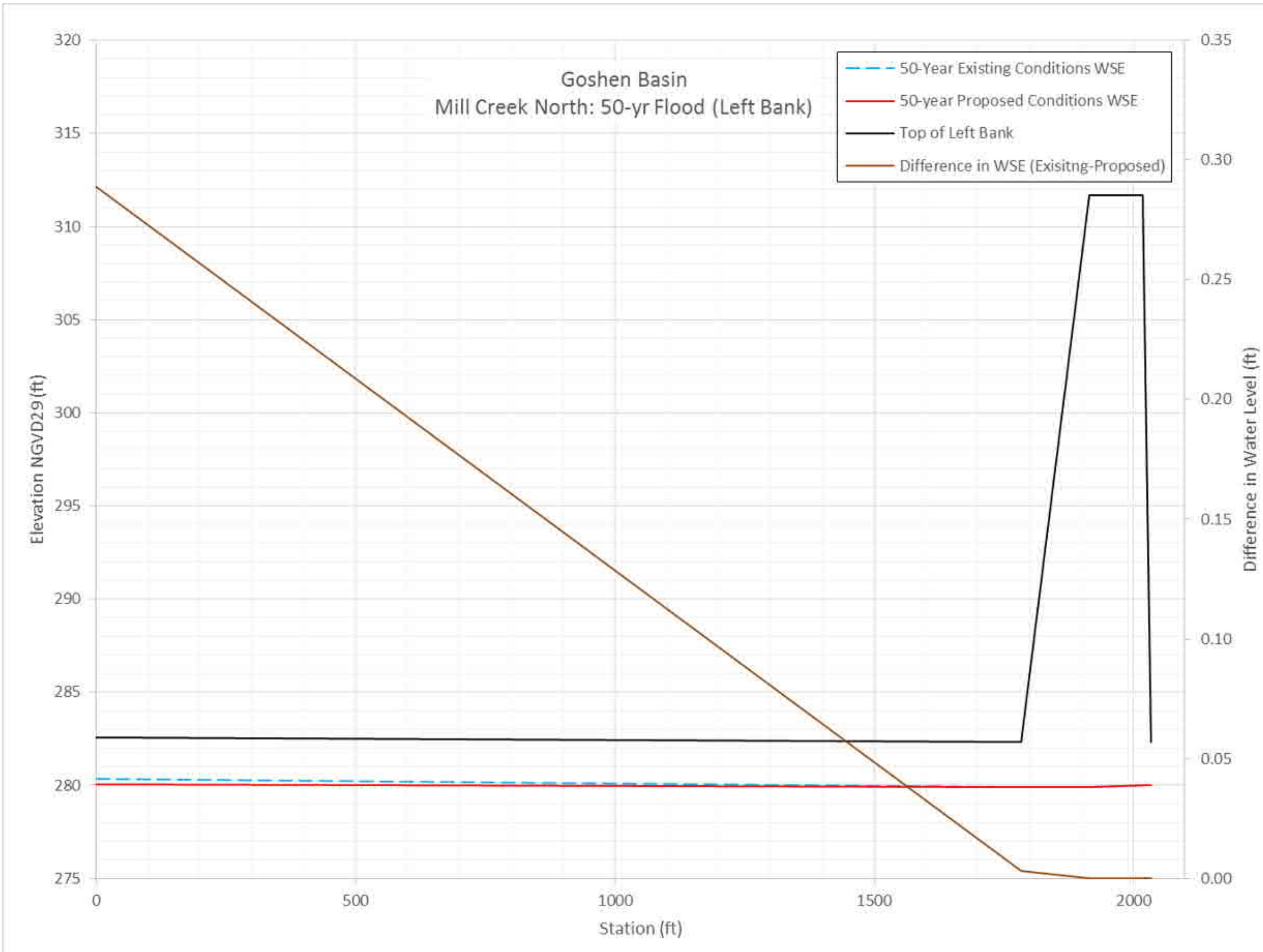

Figure 5.1.1a Comparison of Proposed and Existing Conditions Water Surface Profiles along Left Bank of Mill Creek North for 50yr Flood

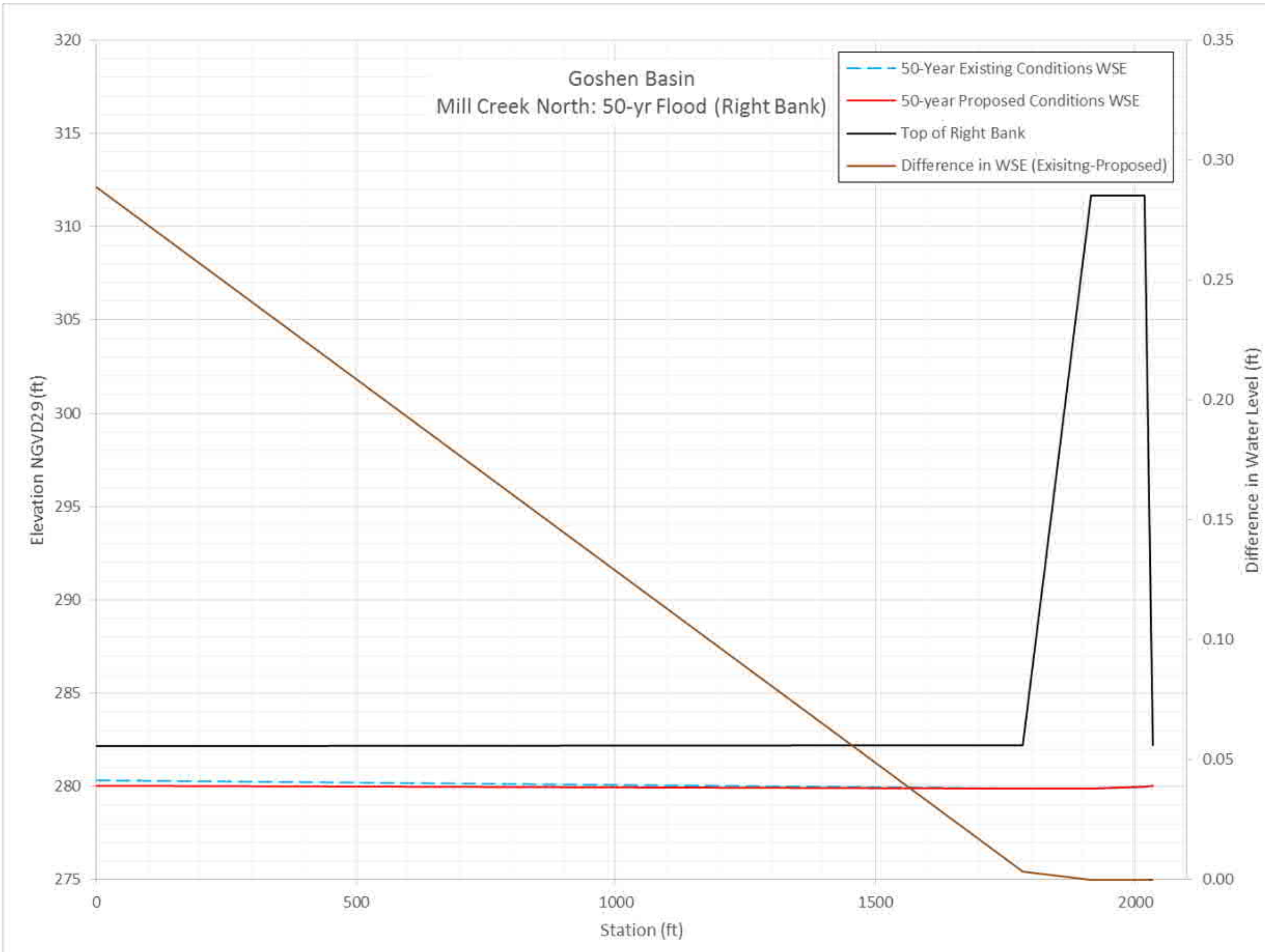

Figure 5.1.1b Comparison of Proposed and Existing Conditions Water Surface Profiles along Right Bank of Mill Creek North for 50yr Flood

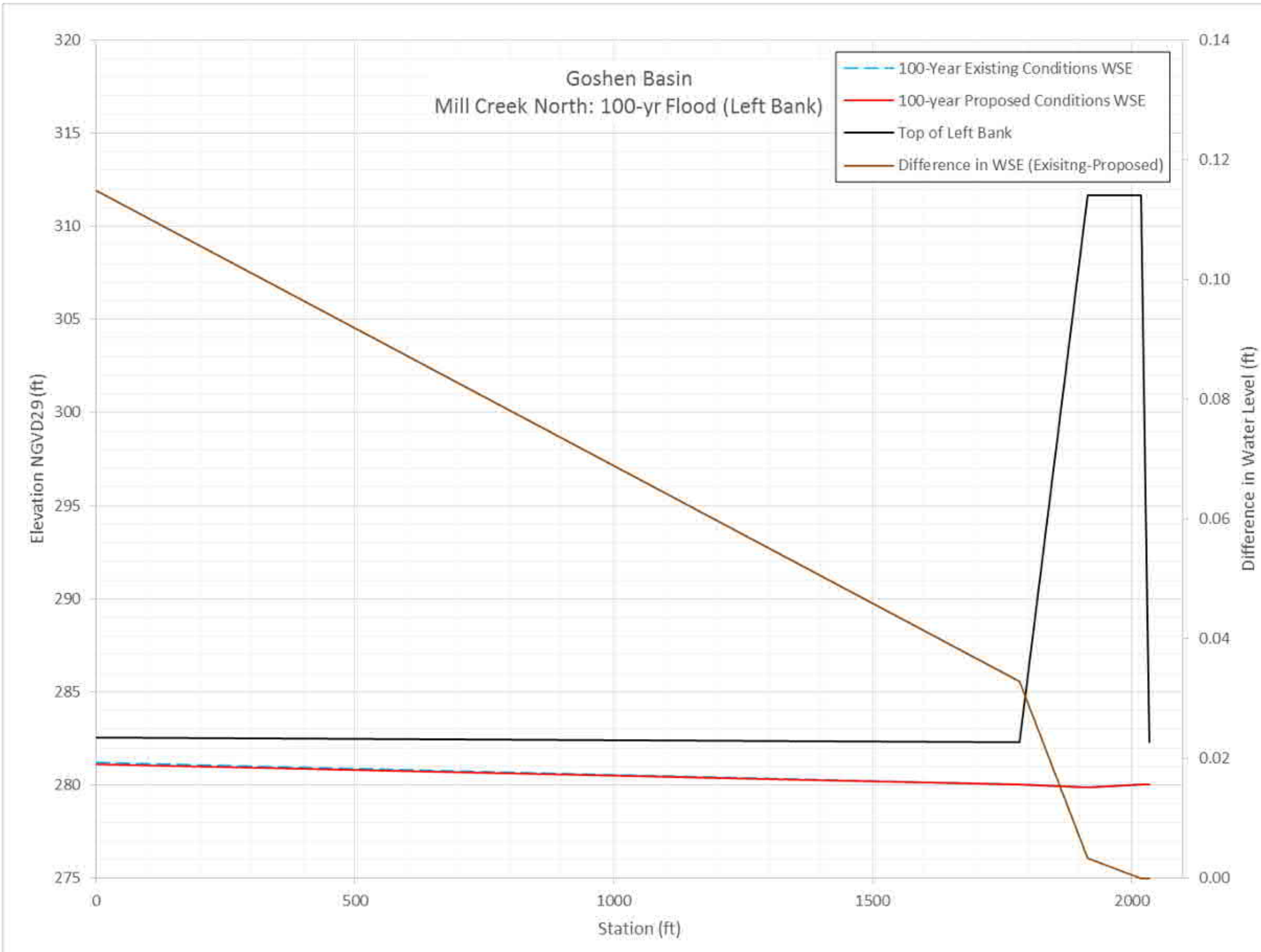

Figure 5.1.2a Comparison of Proposed and Existing Conditions Water Surface Profiles along Left Bank of Mill Creek North for 100yr Flood

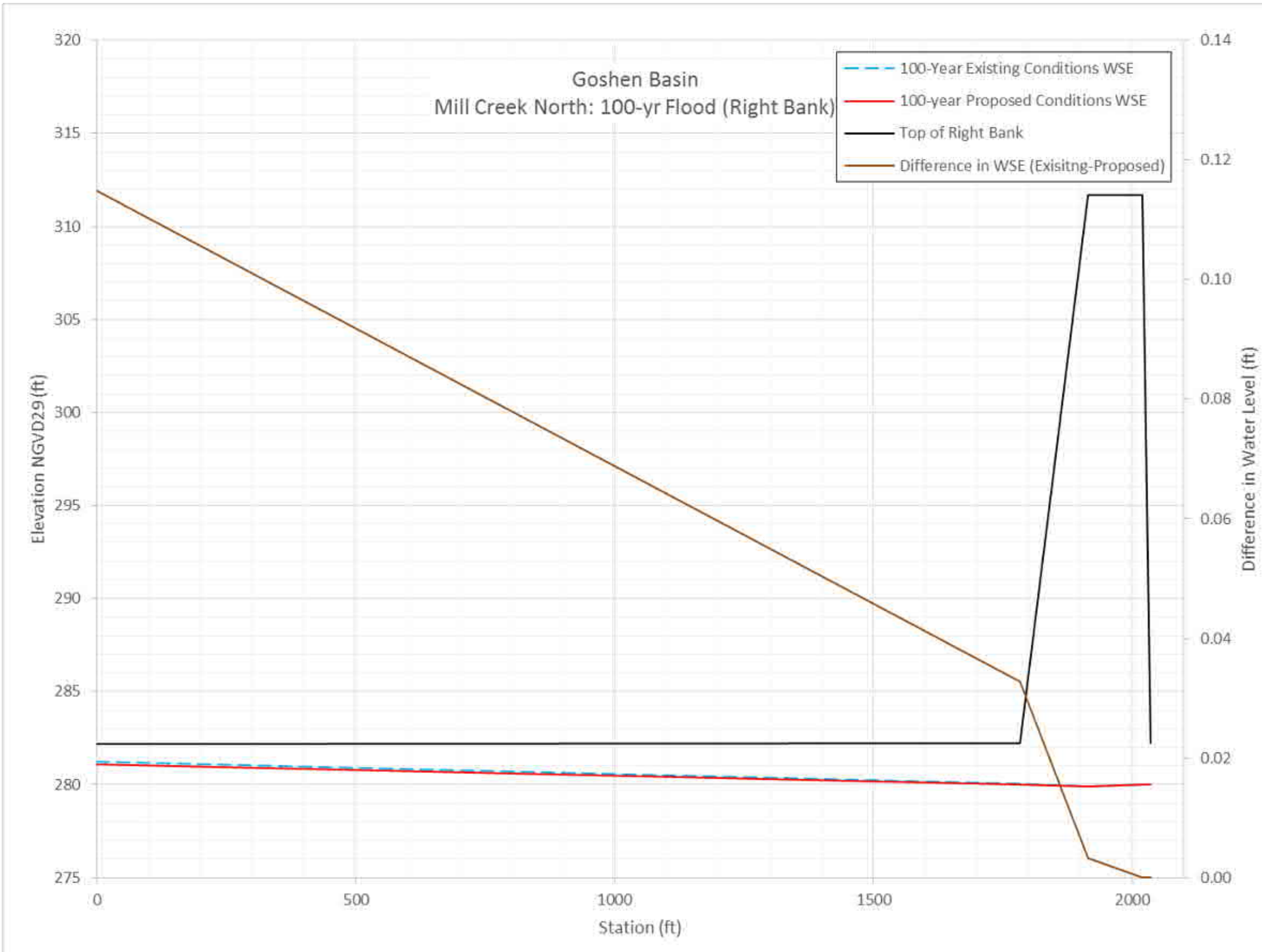

Figure 5.1.2b Comparison of Proposed and Existing Conditions Water Surface Profiles along Right Bank of Mill Creek North for 100yr Flood

5.2 Oakes Basin

Figures 5.2.1a and 5.2.1b compare the peak water surface elevations for the 10 year storm to the top of bank elevations for the left bank and right bank of Packwood Creek, respectively. The channel has an average freeboard of about 5ft relative to the 10-yr existing conditions event. The proposed basin reduces the peak water level during the 10-year event by about 0.8 feet through the channel. Figures 5.2.2a and 5.2.2b compare the peak water surface elevations for the 50-year storm to the top of bank elevations for the left bank and right bank, respectively. The channel has an average freeboard of about 3ft relative to the 50-yr existing conditions event. The proposed basin reduces the 50-year peak water level through the channel by about 0.7 feet, increasing the freeboard to about 3.7 feet. Figures 5.2.3a and 5.2.3b compare the peak water surface elevations for the 100-year storm to the top of bank elevations for the left bank and right bank, respectively. The channel has an average freeboard of about 1.5 ft above the 100-year peak water level. Under existing conditions, overtopping occurs at channel stations 1,200 ft, 2,600 ft, 10,000 ft, 15,000 ft, 13,600 ft and 15,600 ft. The proposed basin reduces the peak water levels by about 0.5 feet along the channel banks, which in turn reduces overtopping at all sections except at station 15,000 ft where a small amount of overtopping still occurs. The reduction of flow under the proposed conditions increases the average freeboard to about 2 ft feet along the channel

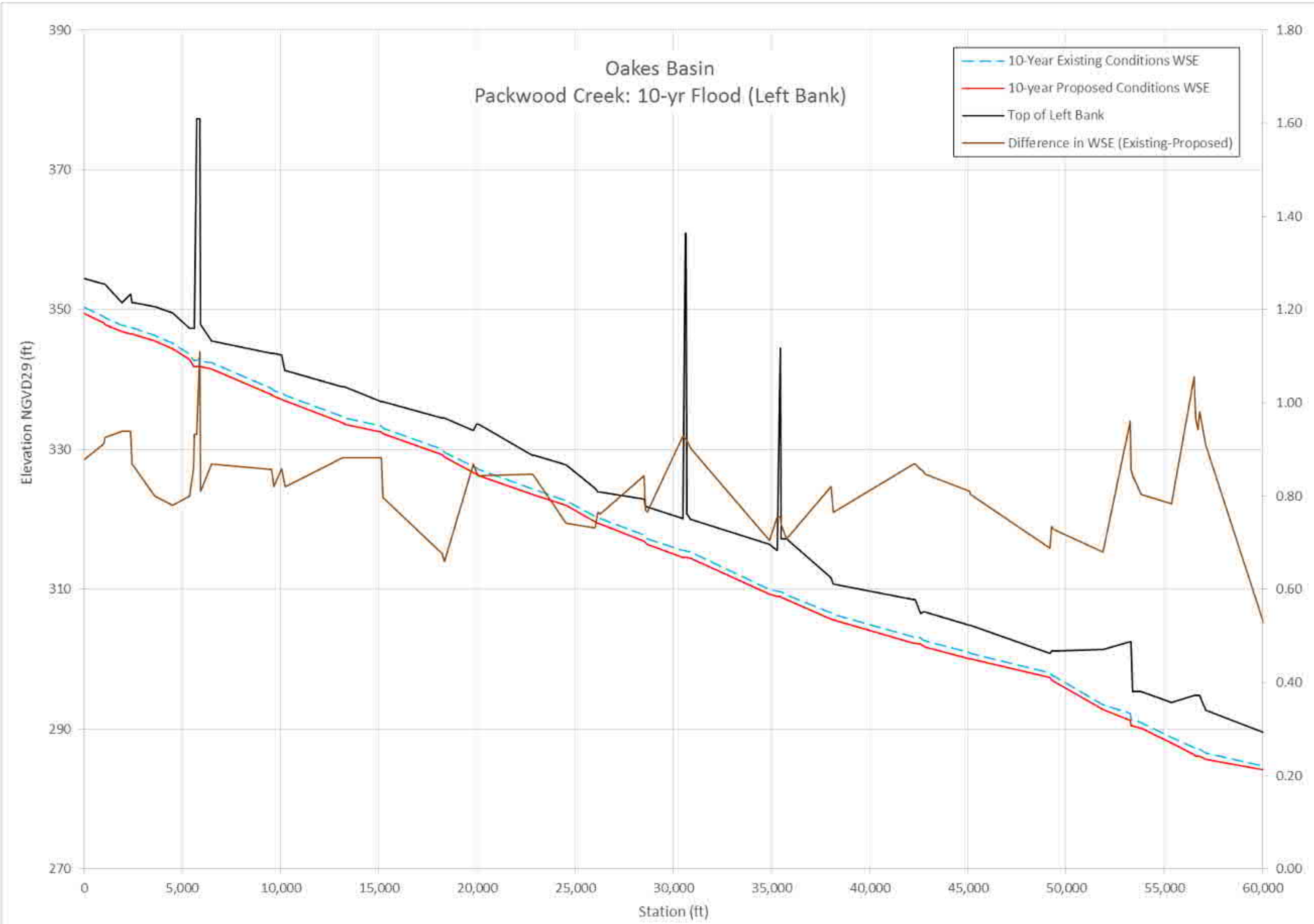

Figure 5.2.1a Comparison of Proposed and Existing Conditions Water Surface Profiles along Left Bank of Packwood Creek for 10yr Flood

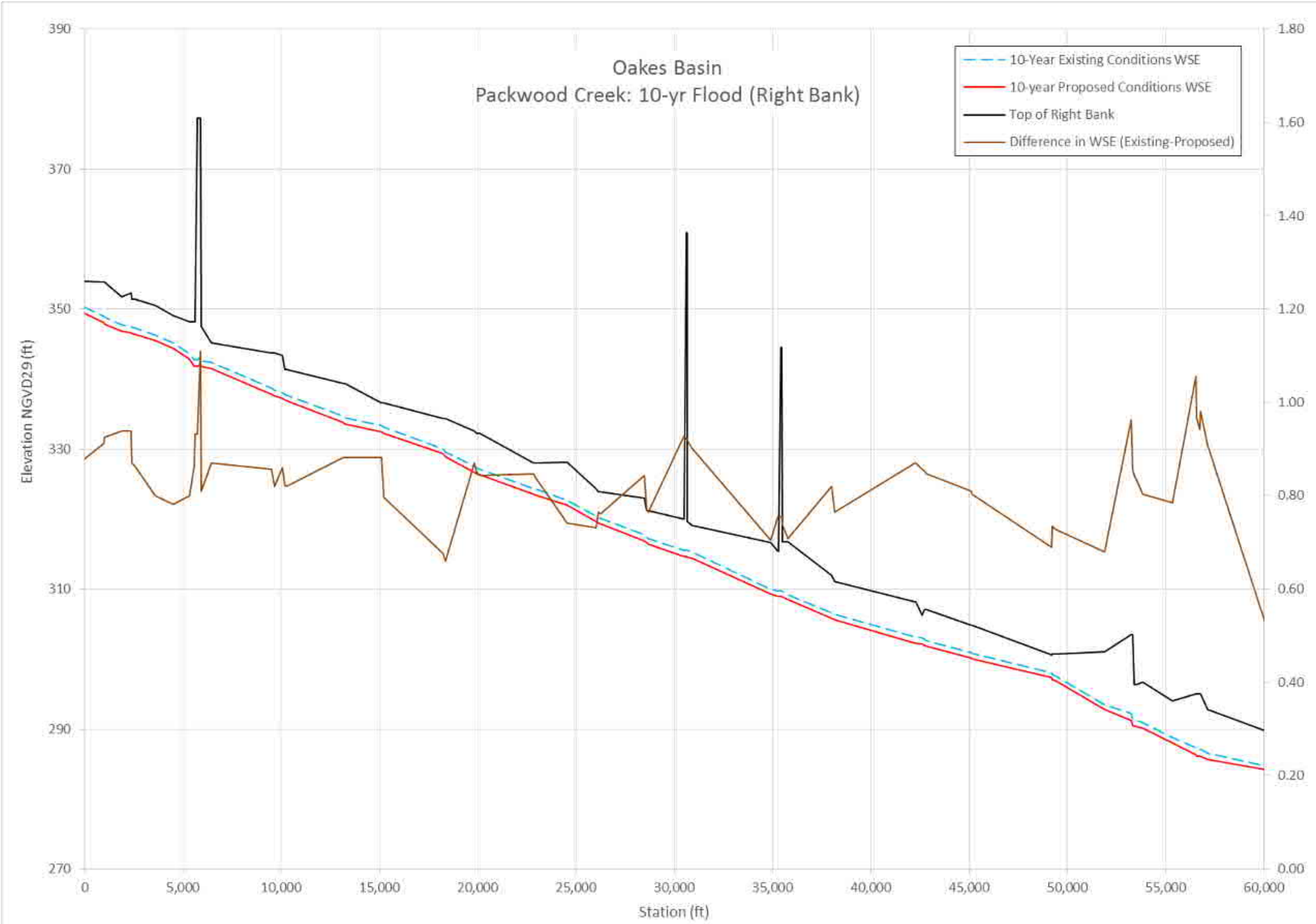

Figure 5.2.1b Comparison of Proposed and Existing Conditions Water Surface Profiles along Right Bank of Packwood Creek for 10yr Flood

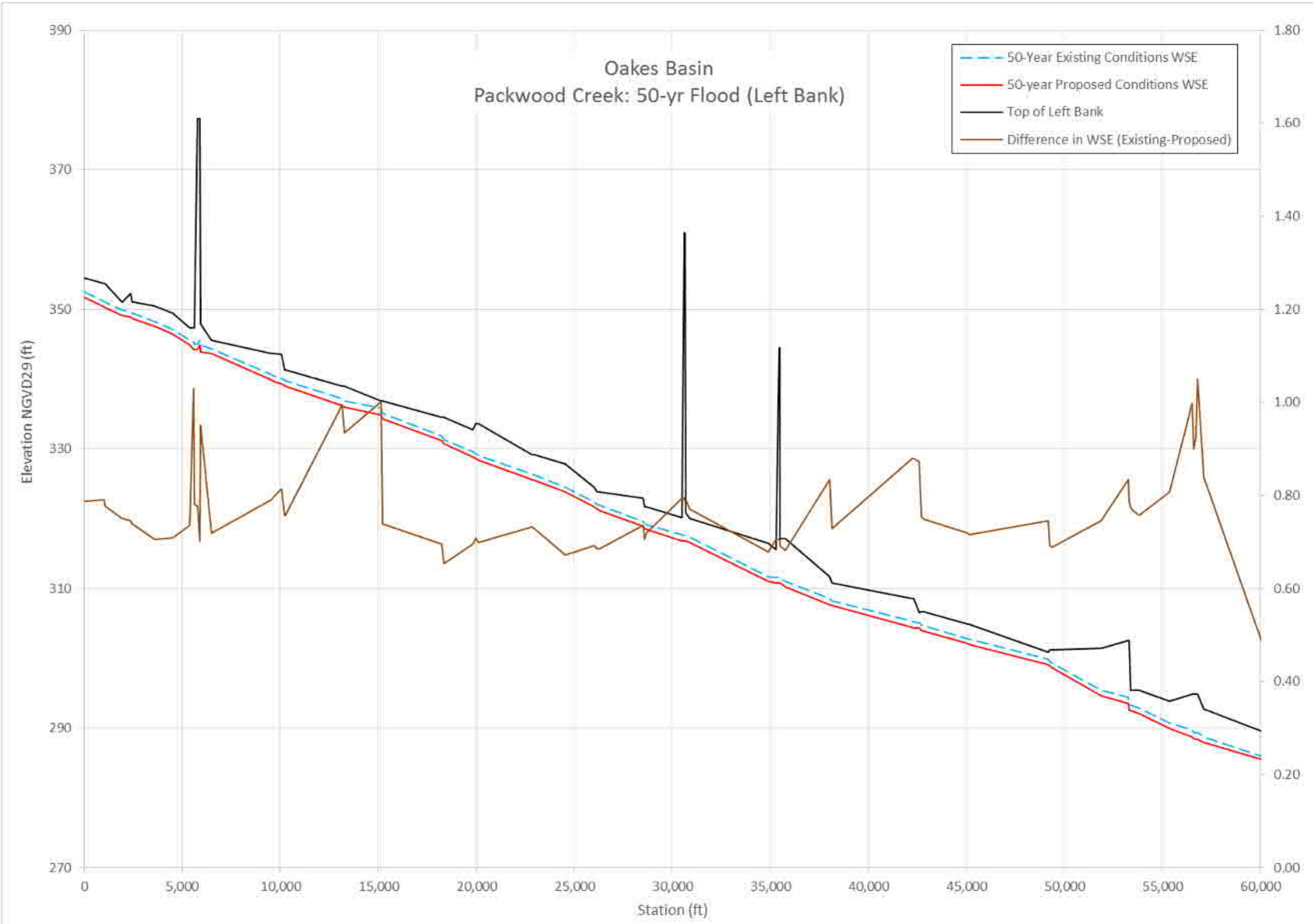

Figure 5.2.2a Comparison of Proposed and Existing Conditions Water Surface Profiles along Left Bank of Packwood Creek for 50yr Flood

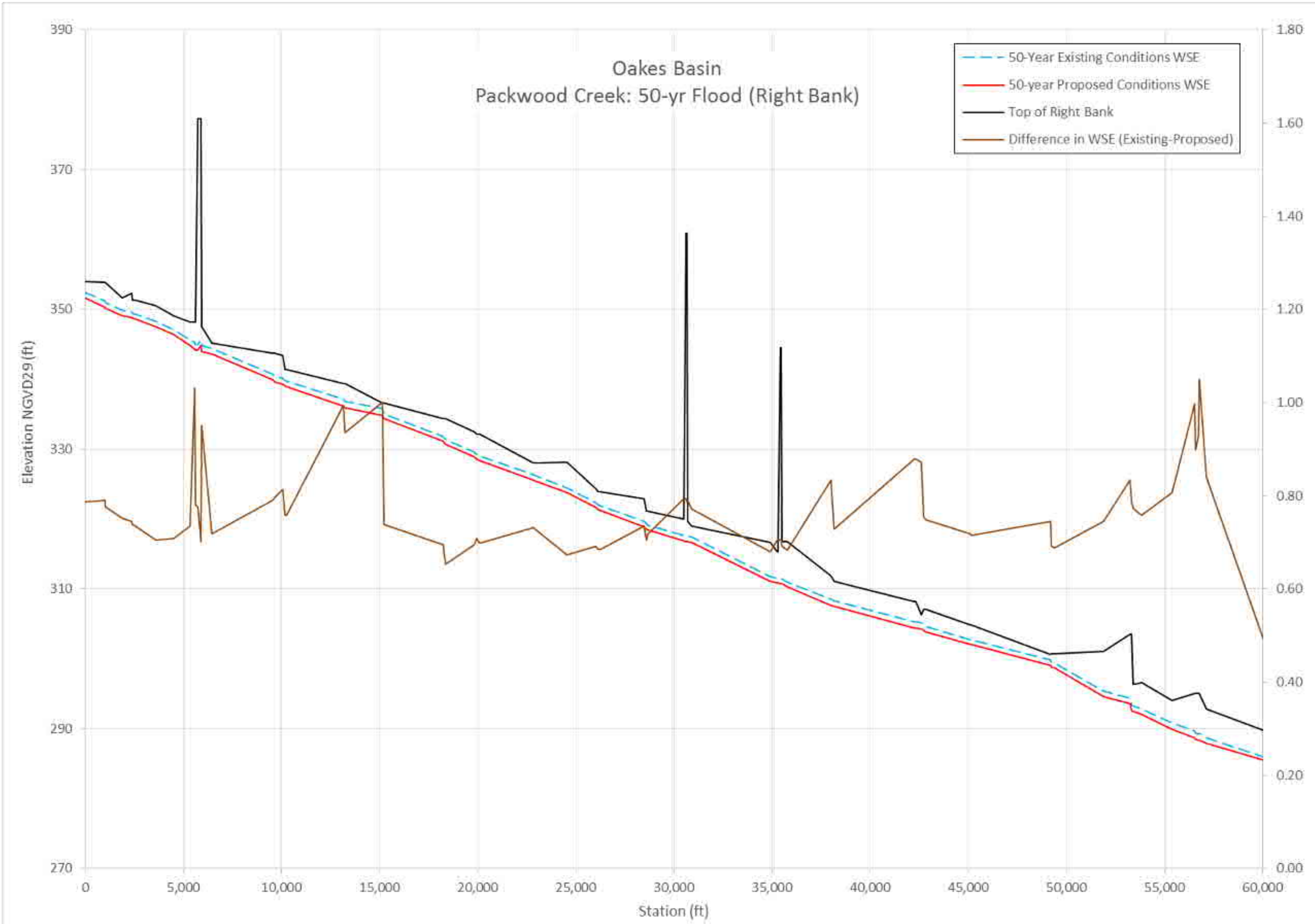

Figure 5.2.2b Comparison of Proposed and Existing Conditions Water Surface Profiles along Right Bank of Packwood Creek for 50yr Flood

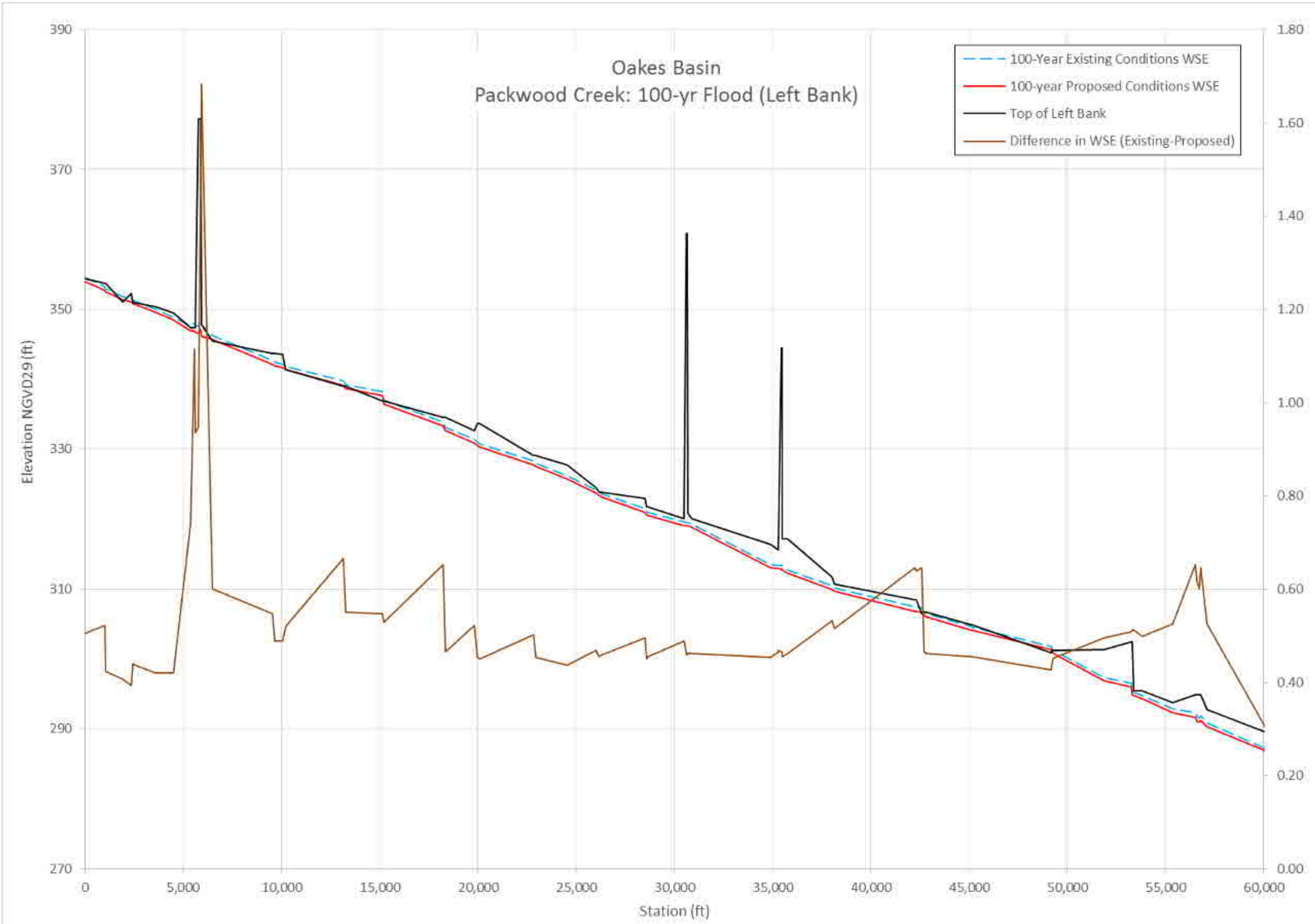

Figure 5.2.3a Comparison of Proposed and Existing Conditions Water Surface Profiles along Left Bank of Packwood Creek for 100yr Flood

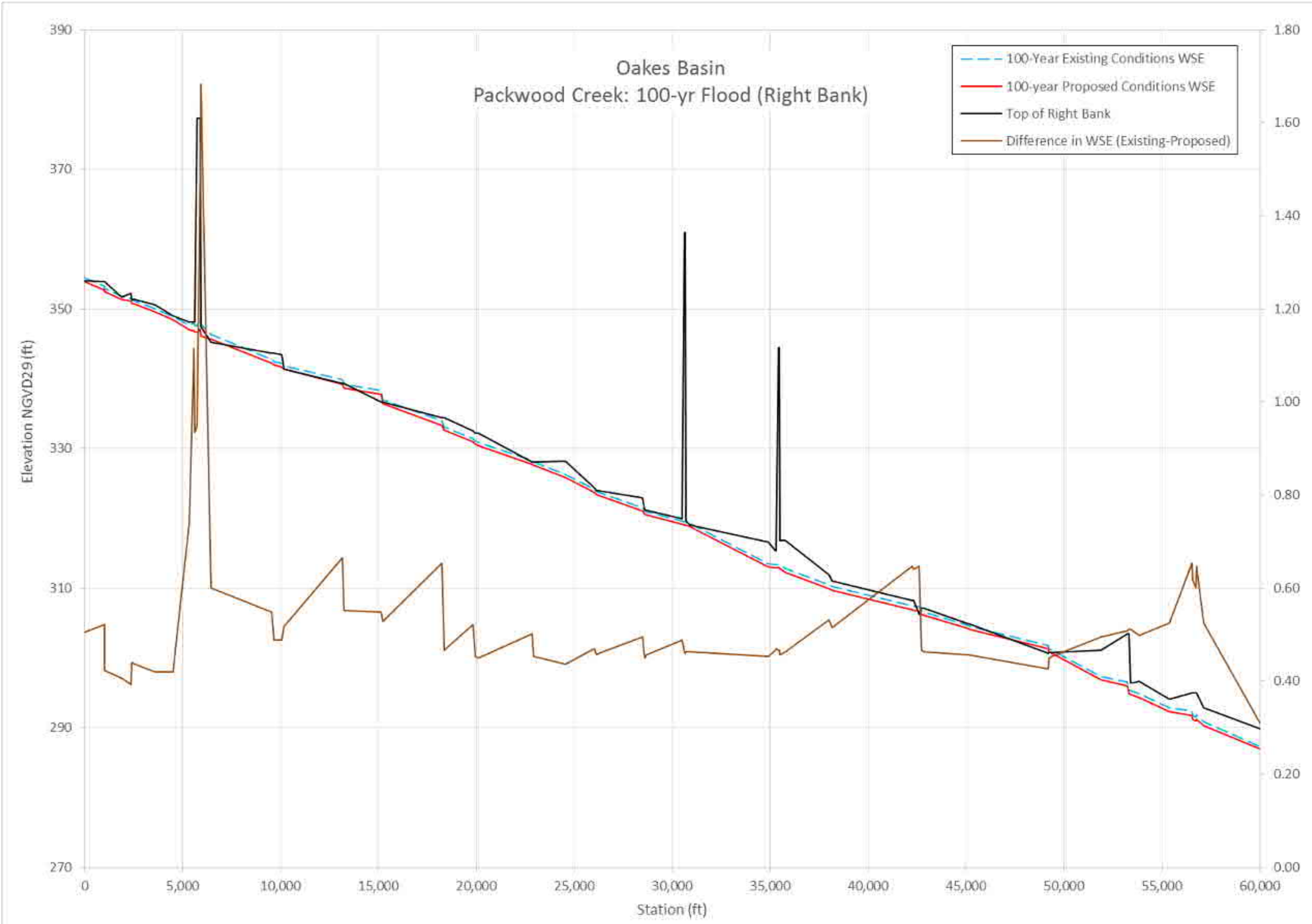

Figure 5.2.3b Comparison of Proposed and Existing Conditions Water Surface Profiles along Right Bank of Packwood Creek for 100yr Flood

5.3 Peoples Basin

Figures 5.3.1a through 5.3.3b compare the peak water surface elevations for the 10-year, 50-year, and 100-year events to the top of bank elevations for the left bank and right bank of Kaweah River. The maximum capacity of the reach was determined through steady state modeling to be about 1,500 cfs before overtopping would begin to occur. The peak flows during all three events exceed 1,500 cfs for both existing and proposed conditions (Figure 4.2.3). Overtopping of the left and right banks occurs for all three events between stations 13,400 and 13,700 under both existing and proposed conditions. During the 50-year and 100-year events, considerable overtopping occurs between stations 0 ft and 160 ft, as well as between stations 6,700 ft to 14,700 ft. This overtopping contributes to overland flow.

The other channel that is affected by the proposed Peoples Basin is Deep Creek. This channel branches out from the Kaweah River at the junction where the channel is proposed. Figures 5.3.4a to 5.3.6b compare peak water surface elevations of existing and proposed conditions for the 10-, 50- and 100-year event. The proposed basin drops the average water levels by about 0.1 feet and does not reduce the water levels significantly.

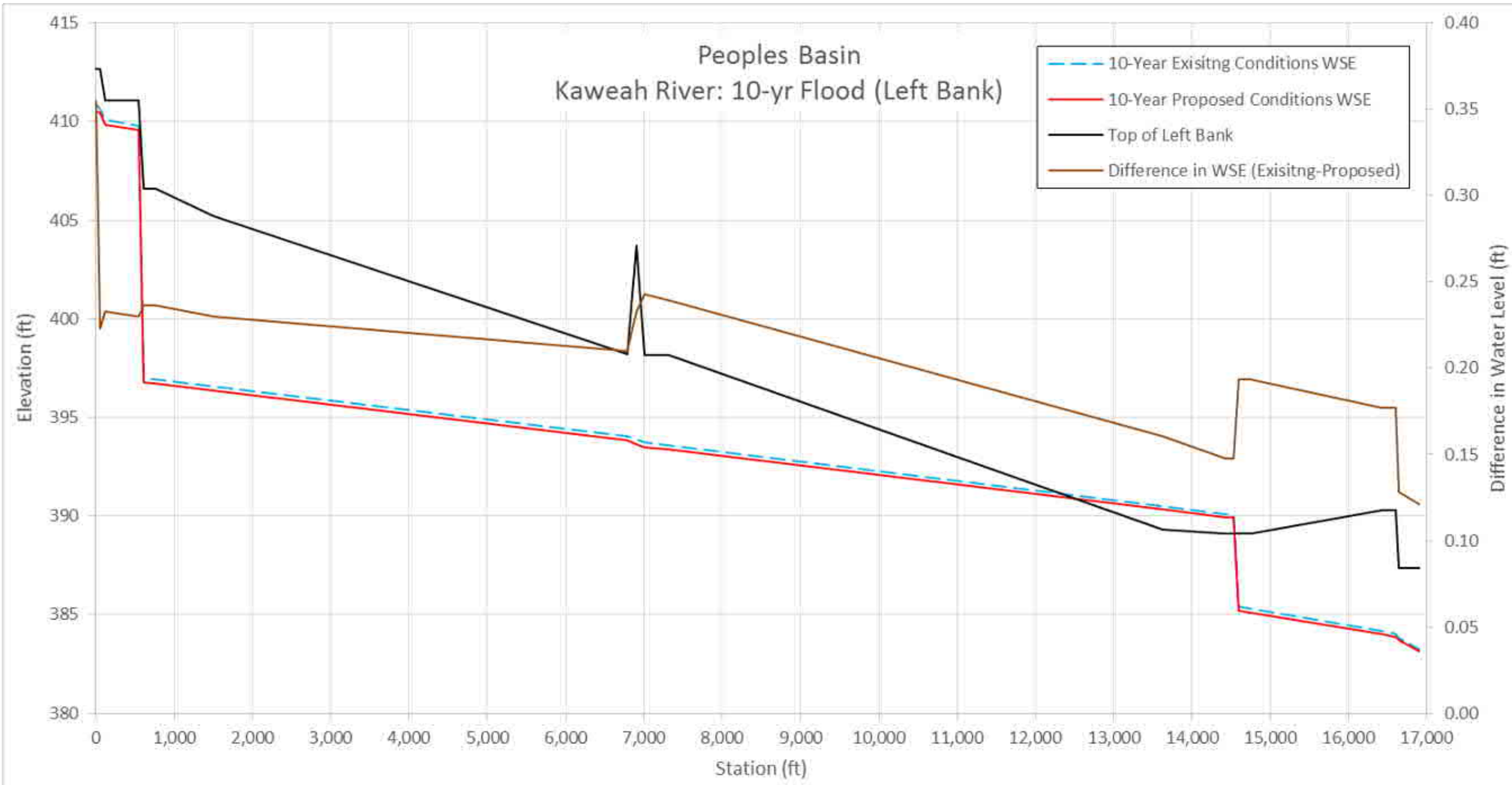

Figure 5.3.1a Comparison of Proposed and Existing Conditions Water Surface Profiles along Left Bank of Kaweah River for 10yr Flood

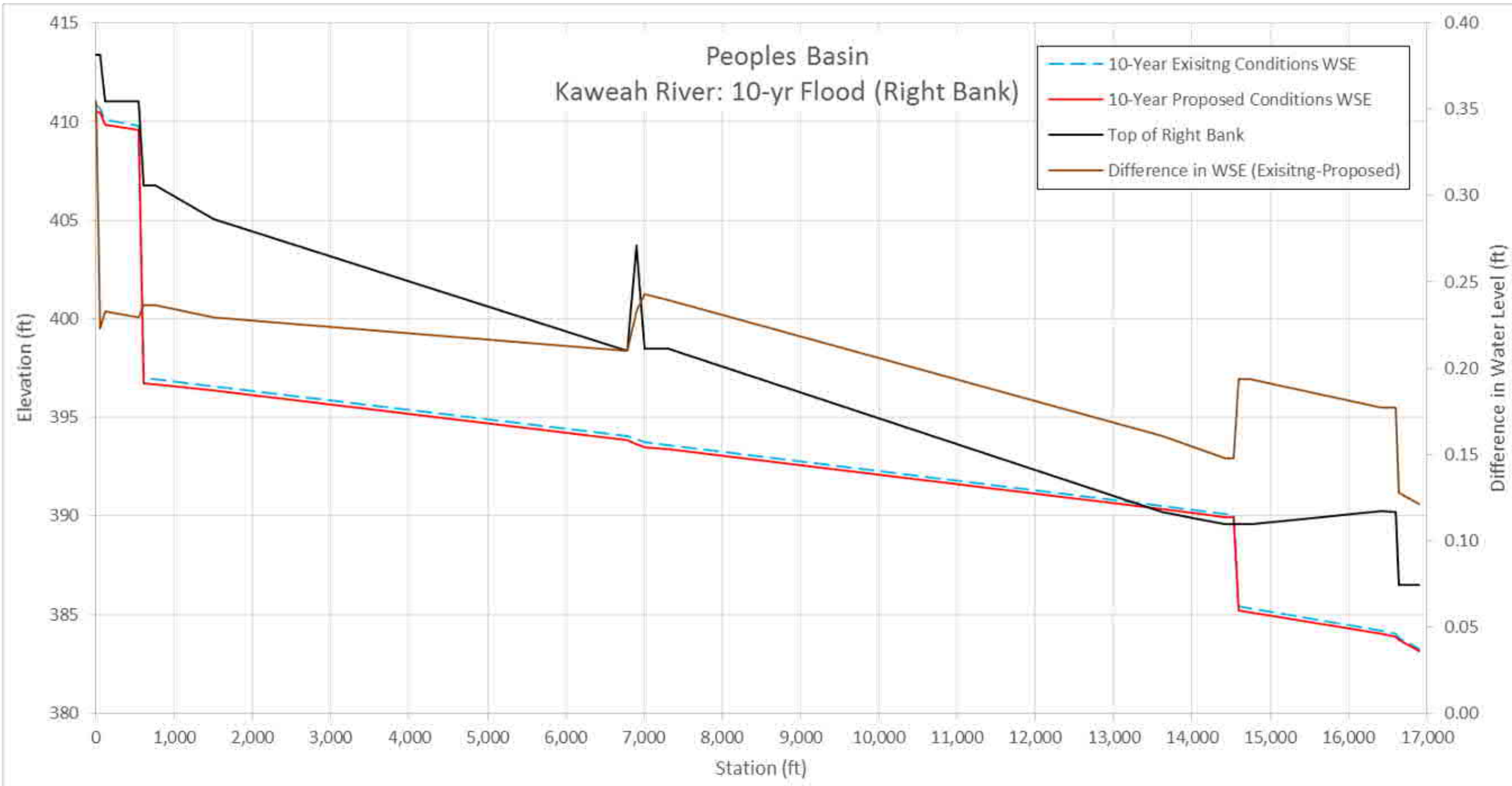

Figure 5.3.1b Comparison of Proposed and Existing Conditions Water Surface Profiles along Right Bank of Kaweah River for 10yr Flood

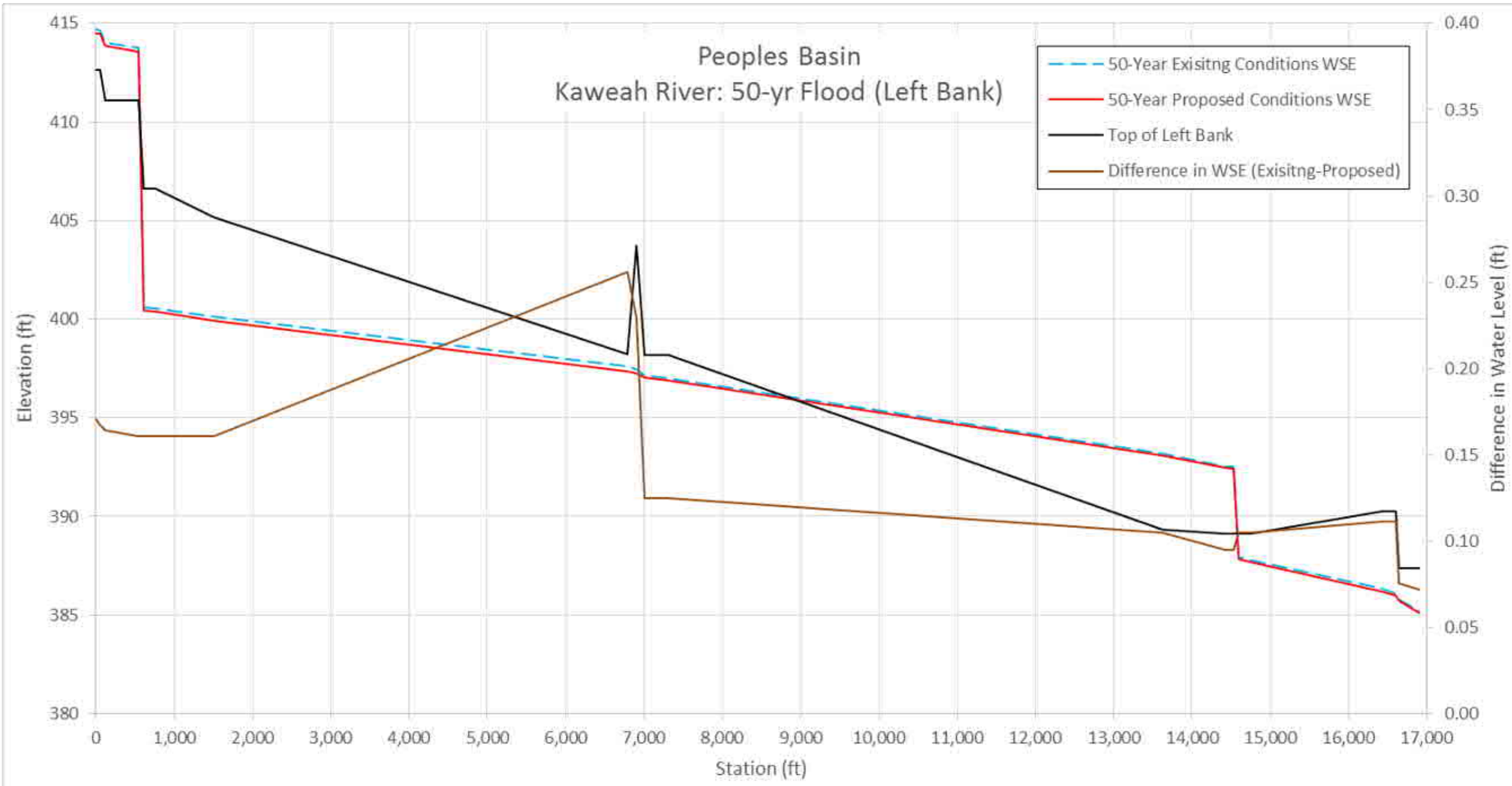

Figure 5.3.2a Comparison of Proposed and Existing Conditions Water Surface Profiles along Left Bank of Kaweah River for 50yr Flood

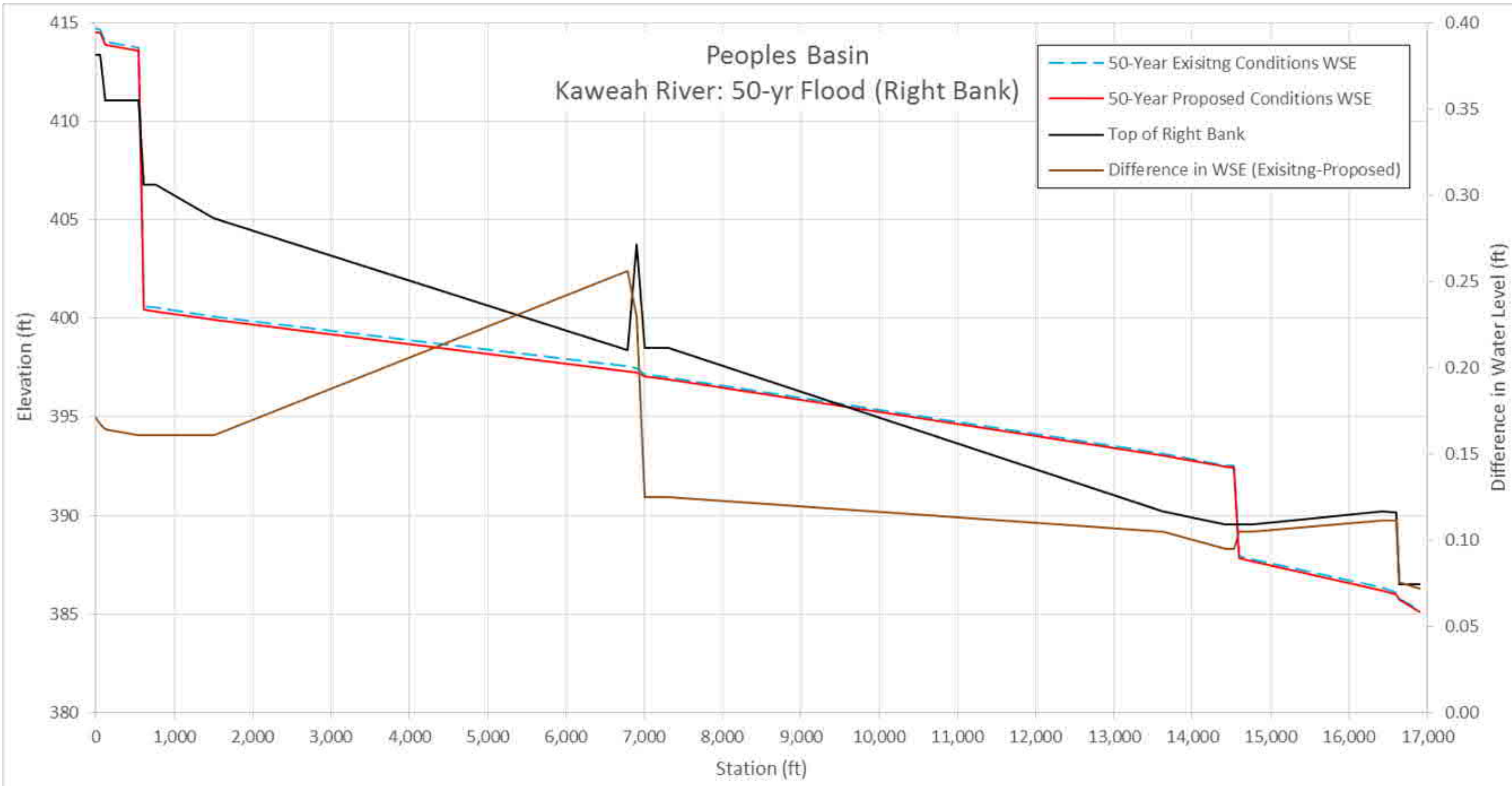

Figure 5.3.2b Comparison of Proposed and Existing Conditions Water Surface Profiles along Right Bank of Kaweah River for 50yr Flood

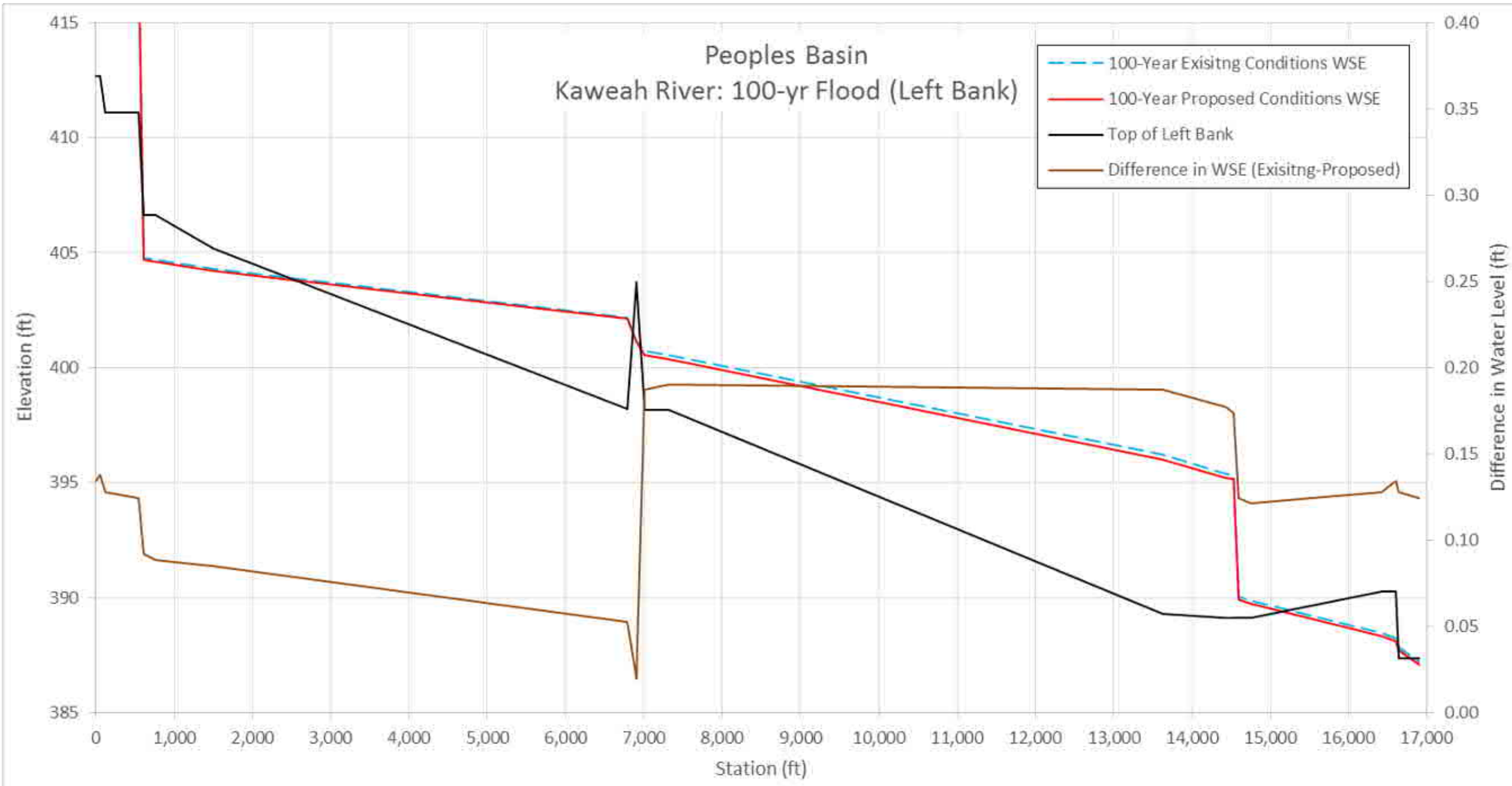

Figure 5.3.3a Comparison of Proposed and Existing Conditions Water Surface Profiles along Left Bank of Kaweah River for 100yr Flood

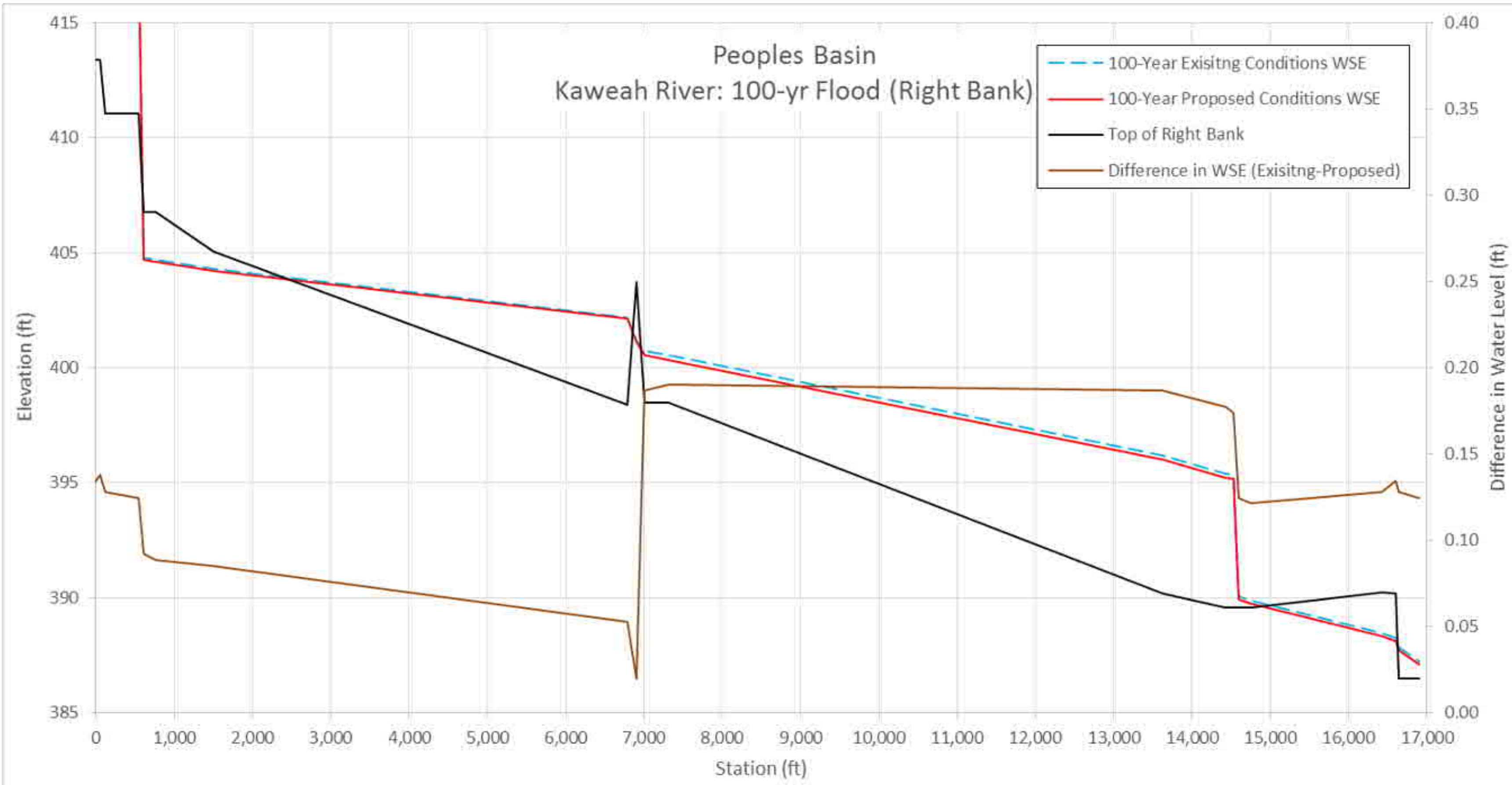

Figure 5.3.3b Comparison of Proposed and Existing Conditions Water Surface Profiles along Right Bank of Kaweah River for 100yr Flood

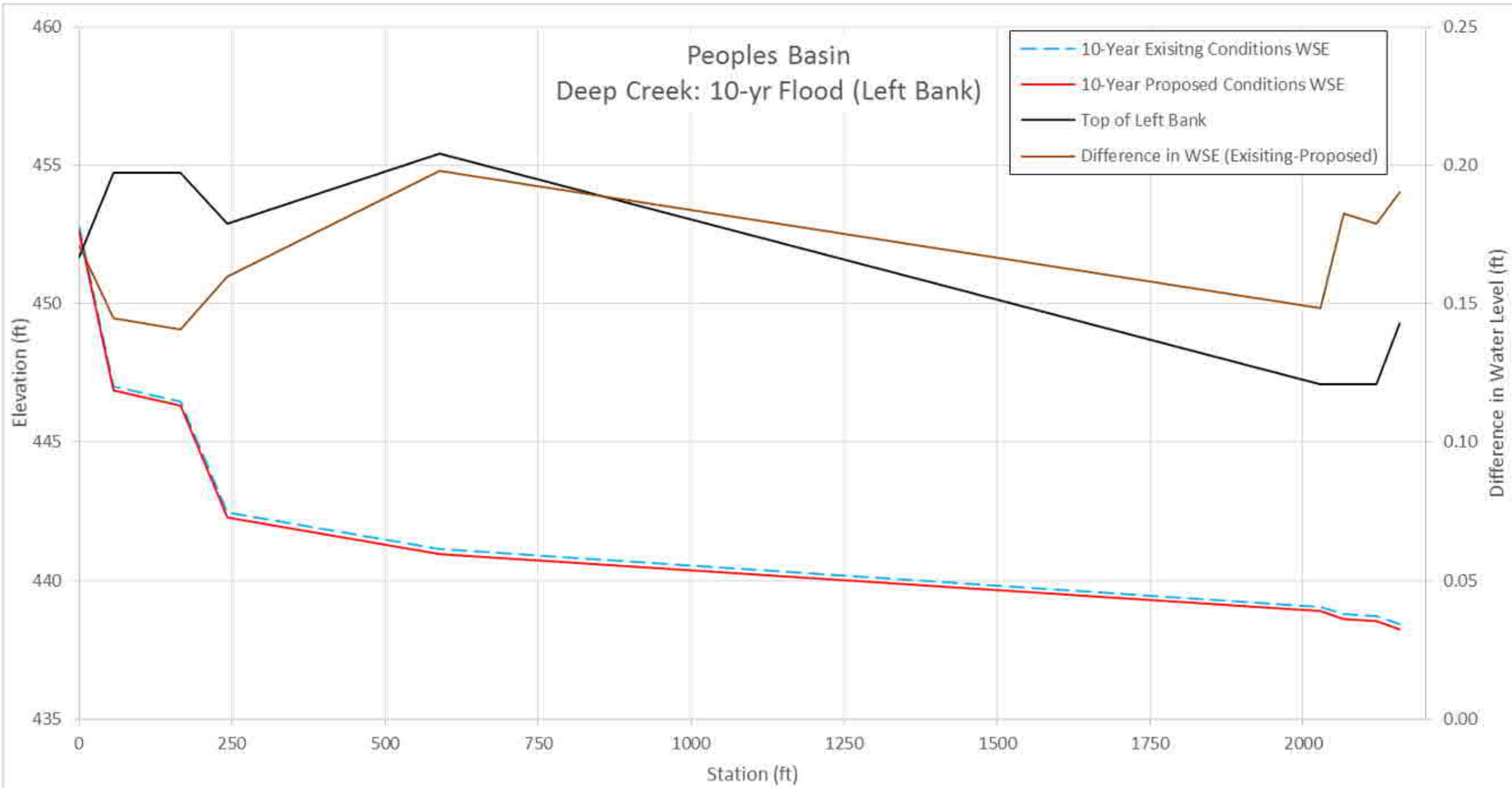

Figure 5.3.4a Comparison of Proposed and Existing Conditions Water Surface Profiles along Left Bank of Deep Creek for 10yr Flood

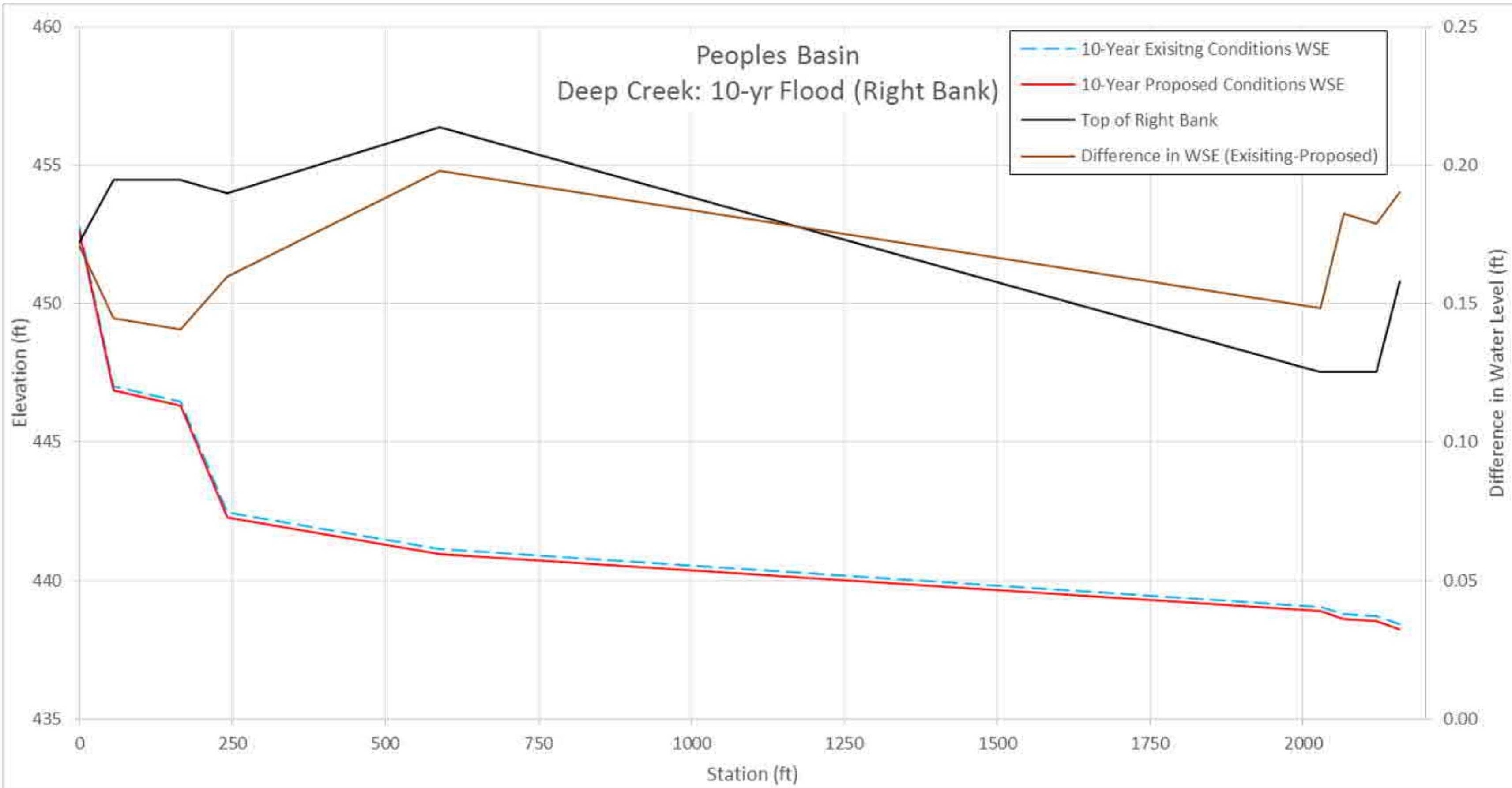

Figure 5.3.4b Comparison of Proposed and Existing Conditions Water Surface Profiles along Right Bank of Deep Creek for 10yr Flood

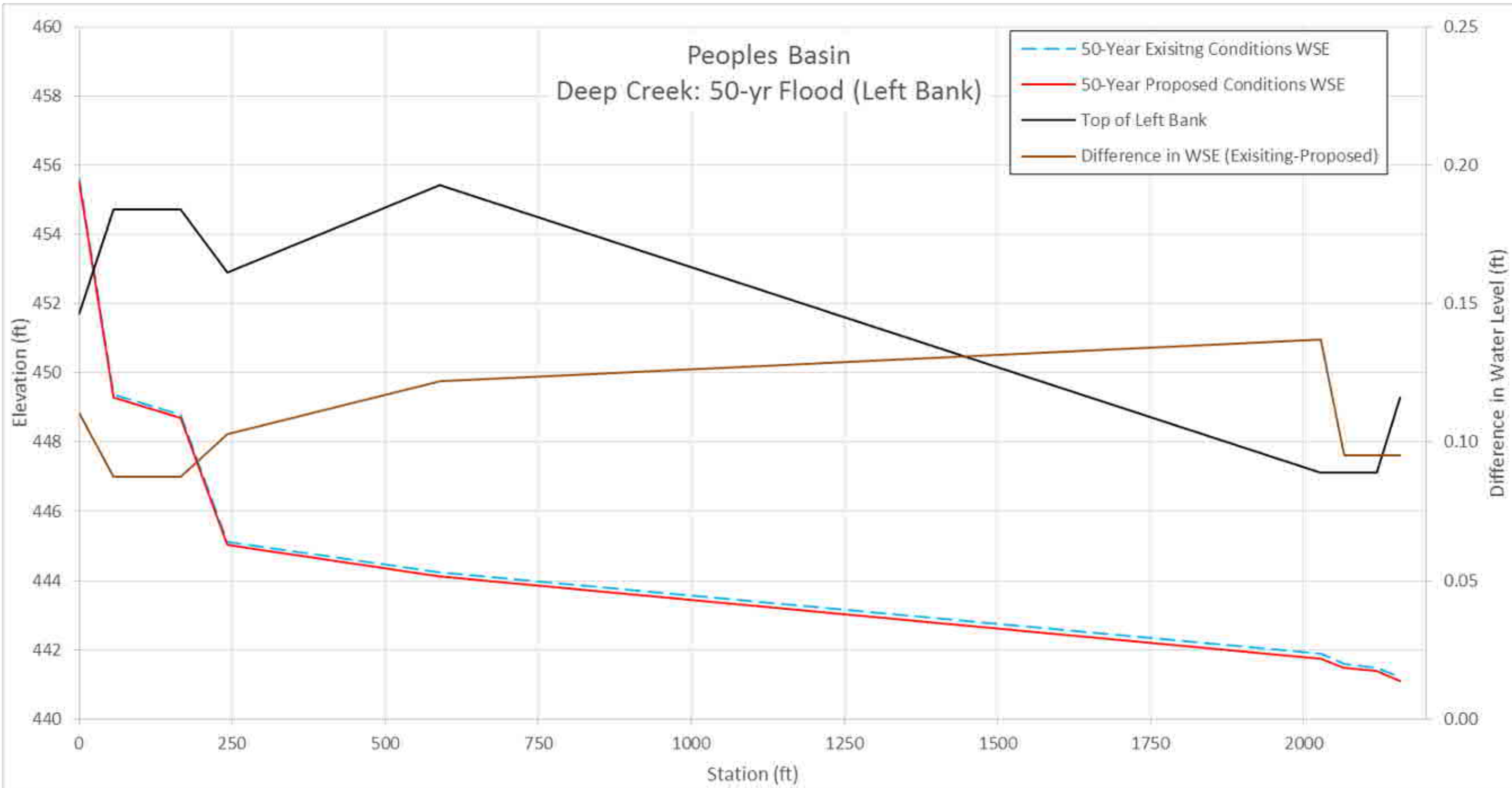

Figure 5.3.5a Comparison of Proposed and Existing Conditions Water Surface Profiles along Left Bank of Deep Creek for 50yr Flood

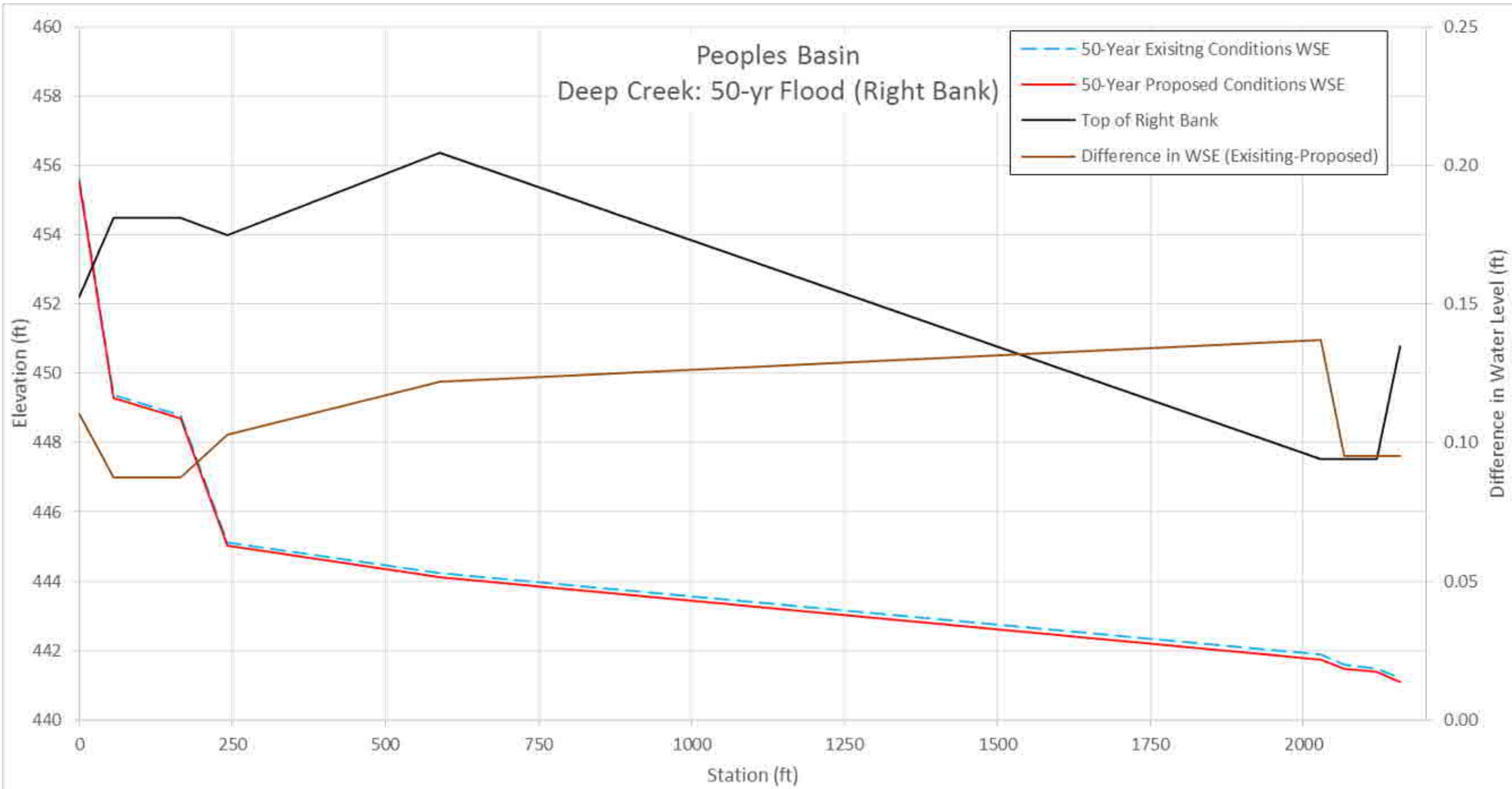

Figure 5.3.5b Comparison of Proposed and Existing Conditions Water Surface Profiles along Right Bank of Deep Creek for 50yr Flood

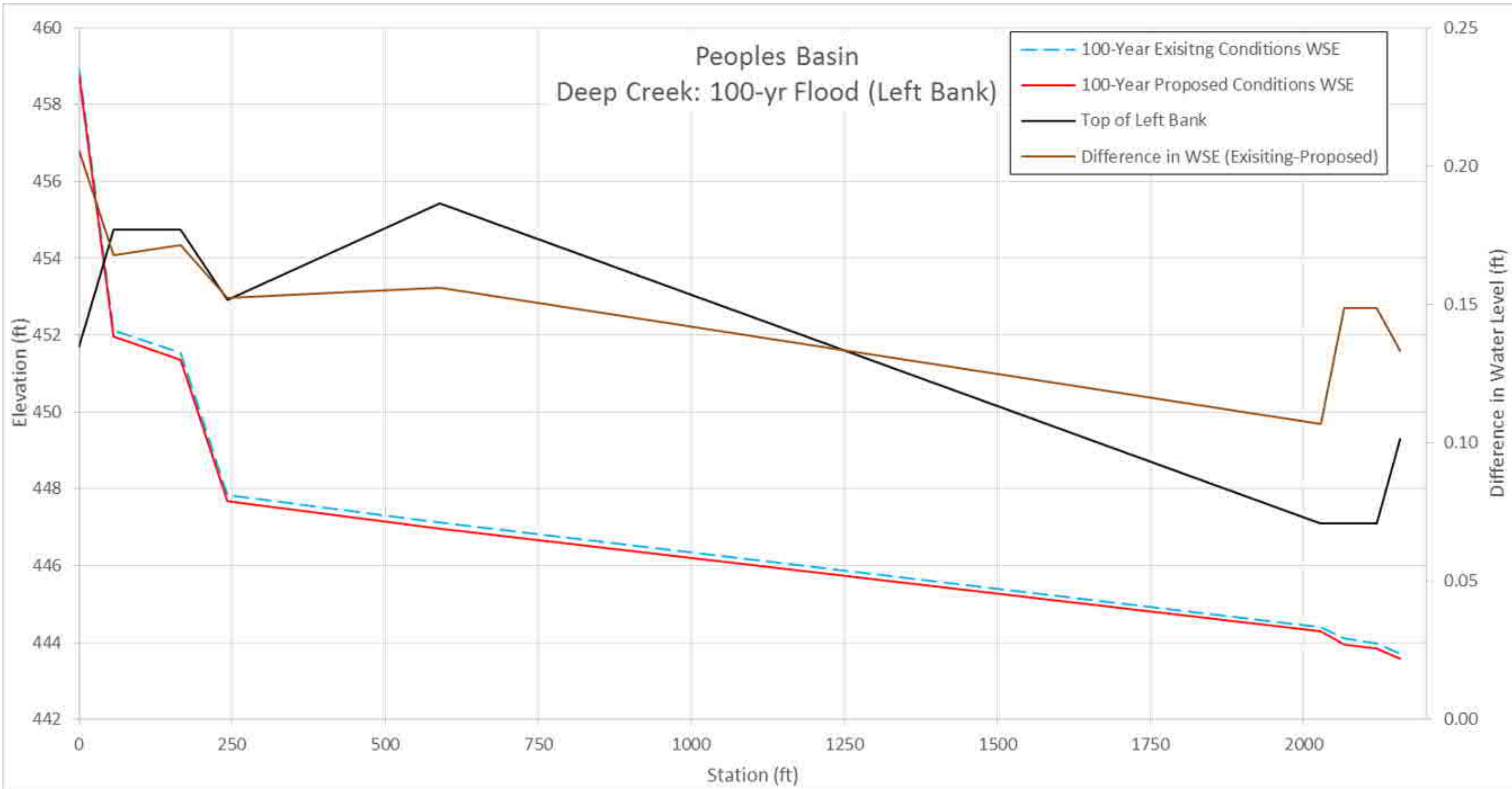

Figure 5.3.6a Comparison of Proposed and Existing Conditions Water Surface Profiles along Left Bank of Deep Creek for 100yr Flood

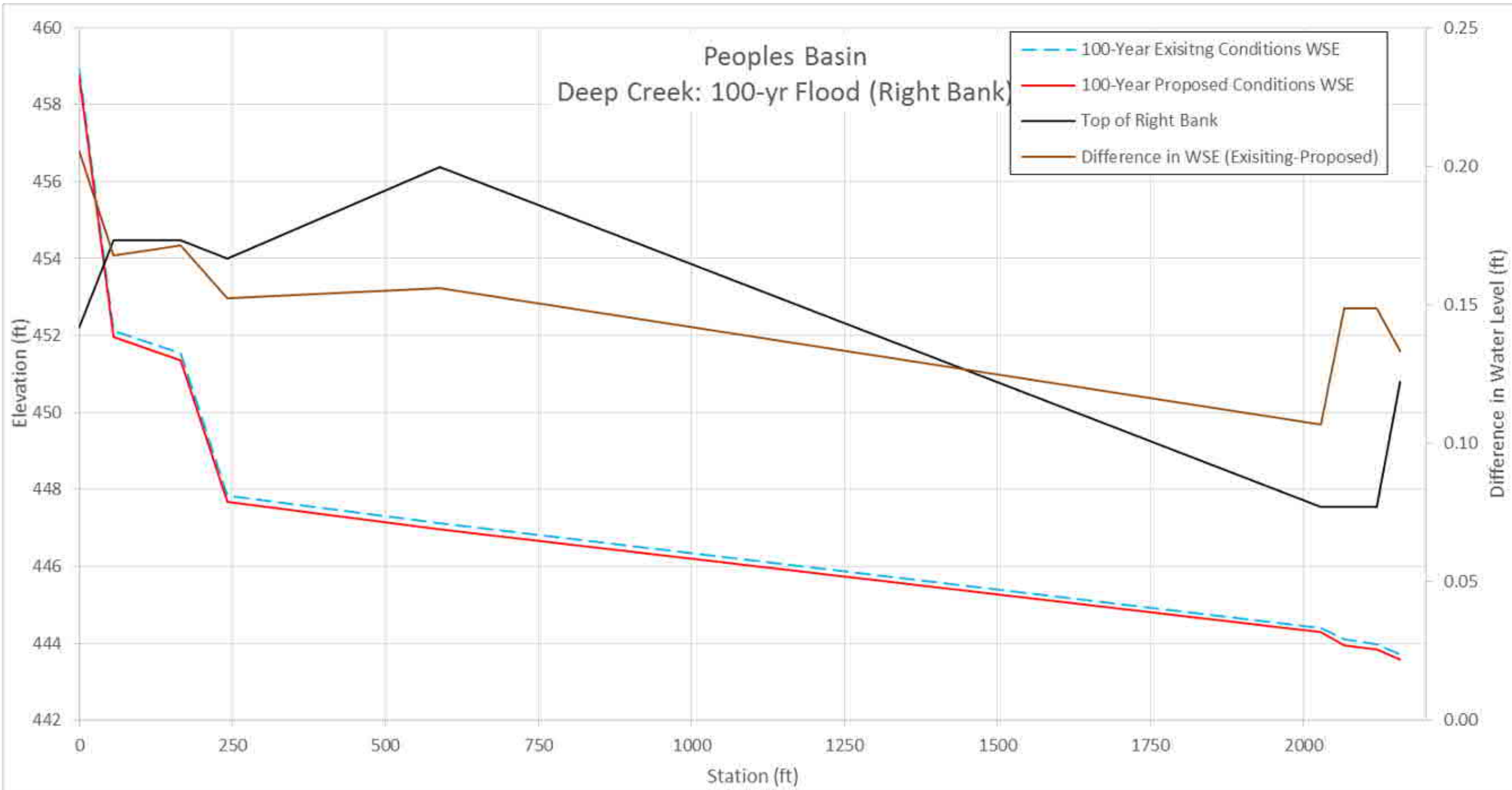

Figure 5.3.6b Comparison of Proposed and Existing Conditions Water Surface Profiles along Right Bank of Deep Creek for 100yr Flood

6. CONCLUSIONS AND RECOMMENDATIONS

NHC conducted a hydrologic and hydraulic study to evaluate the impact of three proposed layoff basins along the Lower Kaweah River system near Visalia, Ca. The objective of this study is to quantify the potential reduction to flood risk provided by the proposed project. The effects of the proposed layoff basins were evaluated using the NHC (2007) MIKE11 model developed as part of the City of Visalia FIS. The existing model was parsed into individual models to evaluate each basin. Existing condition model boundary conditions were taken directly from the NHC (2007) model, while proposed condition boundary conditions reflected the presence of the layoff basins for diverting flow out of the stream. Other model inputs and geometry were consistent with the NHC (2007) MIKE 11 model.

The three individual models are referred to the Goshen MCN model, the Oakes PC model, and the Peoples KR model. The Goshen MCN modeled the effects of the Goshen Basin on the Mill Creek North. The proposed condition hydrograph removed 24.5 cfs from the channel for approximately 8 hours to replicate filling 17 AF of Goshen Basin at the design maximum diversion rate. The Oakes PC model evaluated the impacts of the Oakes Basin on Packwood Creek. The proposed condition hydrograph for the Oakes PC model had 100 cfs removed for 15 hours to account for the filling of Oakes Basin expanded section from an empty to completely full condition at the design maximum diversion rate. The Peoples KR model evaluated the impact of Peoples Basin on the Kaweah River and Deep Creek. The proposed condition for the Peoples KR model reduced flows by 100 cfs for 20 hours to account for flow filling the Peoples Basin an empty to completely full condition at the design maximum diversion rate.

The 1-D MIKE11 models provide a comparative analysis of the effects of the proposed basins on water levels downstream of the basins during infrequent storm events. Table 6.1 shows an average drop in peak water levels due to the proposed basins in each channel. Reducing the water peak water level in channels reduces the likelihood of overtopping and overland flooding. The Goshen Basin has enough storage and a large enough inflow structure to capture the entire 10-year storm event within the basin and reduces the total volume of water moving through the channel by 30% during the 50-yr event, and 5% during the 100-yr event. Packwood Creek overtops its banks at five locations during the 100-year flood under existing conditions. By diverting flow into Oakes Basin, overtopping will only occur at a single location. The Kaweah River also overtops during the 100-year storm event under existing conditions. The limited volume of the Peoples Basin relative to the peak flows through the Kaweah River limits its effectiveness in reducing flood levels during the three storm events.

Table 6.1: Average drop in water levels in feet

Proposed Basins	**Channels Impacted by Basins**	Return Periods		
		10-yr	**50-yr**	**100-yr**
Goshen Basin	*Mill Creek North*	-	0.06	0.03
Oakes Basin	*Packwood Creek*	0.83	0.76	0.54
Peoples Basin	*Kaweah River*	0.2	0.14	0.13
	Deep Creek	0.17	0.1	0.15

7.0 REFERENCES

NHC (2007) FEMA Flood Insurance Study. Visalia California. Report Prepared for FEMA Region IX.

Provost (2014) Personal Correspondence via e-mail with Chad Wegley, February 19, 2014

APPENDIX A

Table A.1: Goshen Basin Results

			Existing Conditions						Proposed Conditions		Drop in Water Level	
Chainage (ft)	Top of Left Bank (ft)	Top of Right Bank (ft)	10yr Flood (FIS Model) (ft)	10yr Flood (ft)	50yr Flood (FIS Model) (ft)	50yr Flood (ft)	100yr Flood (FIS Model) (ft)	100yr Flood (ft)	50yr Flood (ft)	100yr Flood (ft)	50yr Flood (ft)	100yr Flood (ft)
0	282.55	282.16	279.88	279.88	280.34	280.34	280.27	281.23	280.05	281.11	0.29	0.11
1783	282.31	282.21	279.86	279.86	279.90	279.89	279.89	280.05	279.89	280.02	0.00	0.03
1915	311.68	311.68	279.85	279.85	279.87	279.89	279.87	279.89	279.89	279.89	0.00	0.00
2019	311.68	311.68	279.85	279.85	279.87	280.00	279.86	280.00	280.00	280.00	0.00	0.00
2035	282.31	282.21	279.85	279.85	279.87	280.02	279.86	280.02	280.02	280.02	0.00	0.00

Table A.2: Oakes Basin Results-PC

			Existing Conditions						Proposed Conditions			Drop in Water Level		
Chainage (ft)	Top of Left Bank (ft)	Top of Right Bank (ft)	10yr Flood FIS Model) (ft)	10yr Flood (ft)	50yr Flood FIS Model (ft)	50yr Flood (ft)	100yr Flood FIS Model (ft)	100yr Flood (ft)	10yr Flood (ft)	50yr Flood (ft)	100yr Flood (ft)	10yr Floo d (ft	50yr Flood (ft)	100y r Floo d (ft)
0	354.43	354.00	350.28	350.27	352.46	352.45	354.67	354.48	349.39	351.66	353.98	0.88	0.79	0.51
996	353.70	353.88	348.95	348.95	351.17	351.16	353.65	353.25	348.04	350.37	352.73	0.91	0.79	0.52
1029	353.70	353.88	348.82	348.82	351.03	351.01	353.34	352.90	347.89	350.23	352.48	0.93	0.78	0.42
1899	351.03	351.69	347.79	347.78	349.93	349.90	352.21	351.79	346.84	349.14	351.39	0.94	0.75	0.41
2368	352.24	352.27	347.53	347.52	349.66	349.61	351.86	351.50	346.58	348.87	351.11	0.94	0.74	0.39
2420	350.97	351.37	347.37	347.37	349.47	349.46	351.58	351.26	346.50	348.72	350.82	0.87	0.74	0.44
2546	350.97	351.37	347.26	347.26	349.35	349.33	351.41	351.13	346.40	348.60	350.69	0.86	0.73	0.44
3579	350.41	350.53	346.31	346.30	348.29	348.26	350.41	350.00	345.50	347.56	349.58	0.80	0.71	0.42
4494	349.49	349.07	345.20	345.18	347.21	347.14	349.52	348.88	344.40	346.43	348.46	0.78	0.71	0.42
5352	347.33	348.15	343.74	343.60	346.05	345.61	348.67	347.70	342.80	344.87	346.96	0.80	0.73	0.74
5565	347.33	348.15	343.34	342.70	346.82	345.29	349.60	348.03	341.84	344.26	346.92	0.86	1.03	1.12
5615	347.33	348.15	342.87	342.78	345.42	344.99	348.76	347.59	341.85	344.21	346.66	0.93	0.78	0.94
5746	377.30	377.30	342.85	342.76	345.35	344.97	348.01	347.58	341.83	344.19	346.63	0.93	0.78	0.95
5904	377.30	377.30	344.53	343.11	348.92	345.59	349.86	348.63	342.00	344.89	347.14	1.11	0.70	1.49
5926	347.86	347.49	343.41	342.63	345.94	344.87	348.51	347.80	341.82	343.91	346.12	0.81	0.95	1.68
6472	345.52	345.18	342.40	342.38	345.04	344.38	347.03	346.29	341.51	343.66	345.69	0.87	0.72	0.60
9528	343.70	343.72	338.72	338.71	341.01	340.71	343.45	342.73	337.85	339.91	342.18	0.86	0.79	0.55
9659	343.70	343.72	338.40	338.39	340.73	340.42	343.04	342.43	337.57	339.63	341.95	0.82	0.80	0.49
10063	343.57	343.43	338.09	338.08	340.46	340.14	342.72	342.18	337.22	339.33	341.69	0.86	0.81	0.49
10194	341.32	341.37	337.81	337.80	340.15	339.83	342.18	341.90	336.98	339.07	341.38	0.82	0.76	0.52
10250	341.32	341.37	337.73	337.72	340.07	339.74	342.08	341.83	336.90	338.99	341.31	0.82	0.76	0.52

			Existing Conditions						Proposed Conditions			Drop in Water Level		
Chainage (ft)	Top of Left Bank (ft)	Top of Right Bank (ft)	10yr Flood FIS Model) (ft)	10yr Flood (ft)	50yr Flood FIS Model (ft)	50yr Flood (ft)	100yr Flood FIS Model (ft)	100yr Flood (ft)	10yr Flood (ft)	50yr Flood (ft)	100yr Flood (ft)	10yr Floo d (ft	50yr Flood (ft)	100y r Floo d (ft)
13162	338.98	339.37	334.70	334.69	337.61	337.17	339.56	339.84	333.80	336.17	339.18	0.88	0.99	0.67
13254	338.98	339.37	334.51	334.49	337.31	336.87	338.80	339.25	333.61	335.94	338.69	0.88	0.94	0.55
15123	336.85	336.62	333.37	333.35	336.32	335.82	337.64	338.28	332.47	334.82	337.73	0.88	1.00	0.55
15218	336.85	336.62	333.10	333.09	335.40	335.07	337.12	337.01	332.29	334.33	336.48	0.80	0.74	0.53
18225	334.52	334.37	329.99	329.99	332.15	331.83	334.07	333.95	329.31	331.14	333.29	0.68	0.70	0.65
18356	334.52	334.37	329.61	329.61	331.64	331.34	333.16	333.08	328.95	330.68	332.61	0.66	0.65	0.47
19824	332.71	332.54	327.59	327.59	329.90	329.57	331.53	331.44	326.72	328.88	330.92	0.87	0.70	0.52
19955	333.64	332.19	327.33	327.32	329.58	329.27	331.13	331.05	326.47	328.56	330.59	0.85	0.71	0.45
20090	333.64	332.19	327.14	327.13	329.36	329.05	330.89	330.82	326.28	328.35	330.37	0.84	0.70	0.45
22834	329.12	328.04	324.40	324.38	326.68	326.35	328.32	328.26	323.53	325.62	327.76	0.85	0.73	0.50
22934	329.12	328.04	324.30	324.28	326.55	326.23	328.09	328.03	323.44	325.50	327.58	0.84	0.73	0.45
24547	327.79	328.15	322.72	322.70	324.79	324.50	326.28	326.23	321.96	323.83	325.80	0.74	0.67	0.44
26022	324.48	324.37	320.44	320.43	322.65	322.34	324.24	324.19	319.70	321.65	323.72	0.73	0.69	0.47
26153	323.87	323.93	320.22	320.21	322.34	322.04	323.87	323.83	319.45	321.36	323.38	0.76	0.69	0.46
26270	323.87	323.93	320.07	320.07	322.19	321.89	323.72	323.68	319.30	321.20	323.23	0.76	0.69	0.46
28495	322.95	322.94	317.74	317.73	319.92	319.63	321.55	321.51	316.89	318.89	321.01	0.84	0.73	0.50
28593	321.76	321.16	317.44	317.43	319.60	319.31	321.12	321.08	316.66	318.61	320.63	0.77	0.71	0.45
28679	321.76	321.16	317.24	317.23	319.43	319.14	320.97	320.94	316.47	318.43	320.49	0.76	0.72	0.46
30483	320.11	319.98	315.56	315.53	318.00	317.65	319.65	319.61	314.60	316.85	319.12	0.93	0.79	0.49
30615	360.89	360.89	315.53	315.50	317.96	317.61	319.55	319.52	314.58	316.82	319.06	0.92	0.79	0.46
30654	360.89	360.89	315.52	315.50	317.95	317.60	319.54	319.51	314.57	316.81	319.05	0.92	0.79	0.46
30680	320.81	319.64	315.51	315.48	317.93	317.59	319.53	319.49	314.56	316.80	319.03	0.92	0.79	0.46

			Existing Conditions						Proposed Conditions			Drop in Water Level		
Chainage (ft)	Top of Left Bank (ft)	Top of Right Bank (ft)	10yr Flood FIS Model) (ft)	10yr Flood (ft)	50yr Flood FIS Model (ft)	50yr Flood (ft)	100yr Flood FIS Model (ft)	100yr Flood (ft)	10yr Flood (ft)	50yr Flood (ft)	100yr Flood (ft)	10yr Flood (ft	50yr Flood (ft)	100yr Flood (ft)
30892	320.06	319.05	315.34	315.33	317.71	317.39	319.29	319.27	314.43	316.62	318.81	0.90	0.77	0.46
34893	316.44	316.61	309.98	309.97	311.99	311.72	313.48	313.49	309.27	311.04	313.04	0.71	0.68	0.45
35273	315.56	315.36	309.72	309.71	311.82	311.54	313.36	313.36	308.96	310.83	312.90	0.75	0.71	0.47
35306	315.56	315.36	309.72	309.71	311.82	311.54	313.37	313.37	308.96	310.84	312.90	0.75	0.71	0.47
35437	344.49	344.49	309.69	309.69	311.79	311.52	313.34	313.34	308.93	310.81	312.87	0.75	0.71	0.47
35468	344.49	344.49	309.69	309.68	311.79	311.51	313.33	313.34	308.93	310.81	312.87	0.75	0.71	0.47
35484	317.18	316.76	309.64	309.63	311.70	311.42	313.21	313.22	308.89	310.73	312.76	0.74	0.69	0.46
35765	317.18	316.76	309.21	309.20	311.22	310.96	312.74	312.76	308.49	310.28	312.29	0.71	0.68	0.46
38011	311.70	311.91	306.62	306.61	308.78	308.52	310.37	310.48	305.79	307.69	309.95	0.82	0.83	0.53
38143	310.76	311.05	306.38	306.37	308.55	308.26	310.12	310.20	305.60	307.54	309.69	0.76	0.73	0.52
42241	308.51	308.21	303.18	303.16	305.58	305.28	307.06	307.49	302.29	304.40	306.85	0.87	0.88	0.65
42307	308.51	308.21	303.15	303.13	305.55	305.25	307.01	307.45	302.26	304.37	306.81	0.87	0.88	0.64
42589	306.51	306.26	303.06	303.04	305.44	305.14	306.87	307.33	302.19	304.27	306.68	0.86	0.87	0.65
42721	306.71	307.07	302.79	302.78	305.09	304.79	306.36	306.70	301.92	304.04	306.23	0.85	0.75	0.47
42845	306.71	307.07	302.64	302.63	304.92	304.62	306.17	306.52	301.78	303.87	306.06	0.85	0.75	0.46
45085	304.90	304.85	300.91	300.90	303.05	302.78	304.16	304.64	300.09	302.06	304.19	0.81	0.72	0.46
45137	304.90	304.85	300.87	300.86	303.01	302.73	304.11	304.59	300.06	302.01	304.13	0.80	0.72	0.46
49185	300.88	300.63	298.06	298.05	300.15	299.83	300.84	301.79	297.37	299.08	301.36	0.69	0.74	0.43
49241	301.19	300.75	297.78	297.78	299.80	299.53	300.38	301.33	297.04	298.84	300.88	0.73	0.69	0.45
49374	301.19	300.75	297.61	297.60	299.63	299.36	300.20	301.15	296.88	298.67	300.70	0.73	0.69	0.45
51889	301.38	301.05	293.54	293.50	295.81	295.35	296.63	297.34	292.82	294.61	296.85	0.68	0.74	0.50
53255	302.52	303.47	292.36	292.21	295.05	294.40	295.98	296.51	291.25	293.56	296.00	0.96	0.83	0.51

			Existing Conditions						Proposed Conditions			Drop in Water Level		
Chainage (ft)	Top of Left Bank (ft)	Top of Right Bank (ft)	10yr Flood FIS Model) (ft)	10yr Flood (ft)	50yr Flood FIS Model (ft)	50yr Flood (ft)	100yr Flood FIS Model (ft)	100yr Flood (ft)	10yr Flood (ft)	50yr Flood (ft)	100yr Flood (ft)	10yr Floo d (ft	50yr Flood (ft)	100y r Floo d (ft)
53321	302.52	303.47	291.97	291.32	294.59	293.32	295.57	295.34	290.46	292.54	294.83	0.86	0.79	0.51
53402	295.39	296.37	291.93	291.27	294.54	293.24	295.52	295.25	290.43	292.47	294.74	0.84	0.77	0.51
53514	295.39	296.37	291.86	291.20	294.45	293.16	295.44	295.16	290.37	292.39	294.65	0.83	0.77	0.51
53828	295.39	296.65	291.56	290.93	294.10	292.84	295.07	294.81	290.13	292.09	294.31	0.80	0.76	0.50
55361	293.81	294.04	289.41	288.80	292.11	290.77	293.12	292.86	288.01	289.97	292.34	0.78	0.81	0.52
56517	294.88	295.00	288.43	287.36	291.99	289.73	293.42	292.36	286.31	288.73	291.70	1.06	1.00	0.65
56589	294.88	295.00	287.78	287.09	290.87	289.35	292.01	291.77	286.13	288.45	291.15	0.97	0.90	0.62
56720	294.88	295.00	287.74	287.04	290.72	289.29	291.82	291.56	286.10	288.36	290.96	0.94	0.93	0.60
56779	294.88	295.00	287.84	287.09	291.16	289.39	292.22	291.83	286.11	288.34	291.18	0.98	1.05	0.65
57130	292.74	292.83	287.32	286.60	290.13	288.73	291.17	290.87	285.69	287.89	290.34	0.91	0.84	0.52
64131	285.14	285.50	282.15	282.15	282.15	282.15	282.15	282.15	282.15	282.15	282.15	0.00	0.00	0.00

Table A.3: Peoples Basin-KR

			Existing Conditions						Proposed Conditions			Drop in Water Level		
Chainage (ft)	Top of Left Bank (ft)	Top of Right Bank (ft)	10yr Flood FIS Model) (ft)	10yr Flood (ft)	50yr Flood FIS Model (ft)	50yr Flood (ft)	100yr Flood FIS Model (ft)	100yr Flood (ft)	10yr Flood (ft)	50yr Flood (ft)	100yr Flood (ft)	10yr Flood (ft)	50yr Flood (ft)	100yr Flood (ft)
0	412.65	413.37	409.01	410.86	413.32	414.68	416.76	419.23	410.50	414.50	419.09	0.35	0.17	0.13
52	412.65	413.37	408.97	410.68	413.28	414.64	416.72	419.20	410.46	414.47	419.06	0.22	0.17	0.14
118	411.09	411.03	408.04	410.08	412.72	414.03	416.01	418.35	409.85	413.86	418.23	0.23	0.16	0.13
547	411.09	411.03	407.81	409.80	412.43	413.74	415.71	418.03	409.57	413.58	417.91	0.23	0.16	0.12
612	406.62	406.75	394.93	396.99	399.33	400.59	402.44	404.79	396.75	400.43	404.69	0.24	0.16	0.09
760	406.62	406.75	394.89	396.94	399.27	400.52	402.37	404.70	396.70	400.36	404.62	0.24	0.16	0.09
1499	405.19	405.05	394.57	396.58	398.86	400.11	401.94	404.30	396.35	399.95	404.22	0.23	0.16	0.09
6782	398.21	398.37	392.05	394.04	396.31	397.59	399.38	402.19	393.83	397.33	402.14	0.21	0.26	0.05
6906	403.71	403.71	391.89	393.88	396.17	397.46	399.19	401.15	393.65	397.23	401.13	0.23	0.23	0.02
7011	398.17	398.48	391.74	393.72	395.94	397.16	398.97	400.72	393.48	397.03	400.53	0.24	0.12	0.19
7320	398.17	398.48	391.64	393.61	395.80	397.00	398.80	400.54	393.37	396.88	400.35	0.24	0.12	0.19
13630	389.32	390.19	389.15	390.50	392.18	393.17	394.73	396.21	390.34	393.06	396.02	0.16	0.10	0.19
14427	389.12	389.56	388.88	390.10	391.63	392.54	394.00	395.38	389.95	392.45	395.20	0.15	0.10	0.18
14529	389.12	389.56	388.88	390.09	391.61	392.52	393.98	395.35	389.94	392.43	395.18	0.15	0.10	0.17
14595	389.12	389.56	384.48	385.41	387.62	387.94	389.92	390.05	385.21	387.83	389.93	0.19	0.10	0.12
14748	389.12	389.56	384.41	385.31	387.53	387.81	389.80	389.86	385.11	387.70	389.74	0.19	0.10	0.12
16420	390.28	390.23	383.84	384.19	386.59	386.33	389.02	388.45	384.01	386.22	388.33	0.18	0.11	0.13
16609	390.28	390.18	383.77	384.03	386.49	386.11	388.93	388.27	383.85	386.00	388.13	0.18	0.11	0.13
16645	387.35	386.51	383.61	383.82	386.31	385.80	388.67	387.85	383.69	385.73	387.73	0.13	0.08	0.13
16904	387.35	386.51	383.40	383.26	386.05	385.21	388.42	387.23	383.14	385.13	387.11	0.12	0.07	0.12

Table A.4: DC Peoples Basin

			Existing Conditions							Proposed Conditions			Drop in Water Level		
Chainage (ft)	Top of Left Bank (ft)	Top of Right Bank (ft)	10yr Flood FIS Model) (ft)	10yr Flood (ft)	50yr Flood FIS Model (ft)	50yr Flood (ft)	100yr Flood FIS Model (ft)	100yr Flood (ft)	10yr Flood (ft)	50yr Flood (ft)	100yr Flood (ft)	10yr Flood (ft)	50yr Flood (ft)	100yr Flood (ft)
0	451.69	452.20	451.41	452.83	454.60	455.66	457.35	458.95	452.65	455.55	458.75	0.17	0.11	0.21
56	454.74	454.49	445.79	447.00	448.49	449.38	450.79	452.12	446.86	449.29	451.95	0.14	0.09	0.17
166	454.74	454.49	445.28	446.45	447.91	448.79	450.20	451.53	446.31	448.70	451.36	0.14	0.09	0.17
242	452.91	454.00	441.29	442.46	445.03	445.13	448.43	447.84	442.30	445.03	447.69	0.16	0.10	0.15
590	455.44	456.37	440.21	441.14	444.64	444.25	448.26	447.12	440.94	444.13	446.97	0.20	0.12	0.16
2029	447.11	447.54	439.26	439.03	443.67	441.88	447.39	444.40	438.88	441.74	444.29	0.15	0.14	0.11
2067	447.11	447.54	439.13	438.80	443.50	441.58	447.24	444.10	438.62	441.48	443.95	0.18	0.10	0.15
2120	447.11	447.54	439.10	438.72	443.47	441.48	447.21	443.98	438.54	441.38	443.83	0.18	0.10	0.15
2158	449.29	450.79	439.02	438.44	443.33	441.20	446.87	443.71	438.25	441.10	443.58	0.19	0.10	0.13

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MEMORANDUM

To: Provost & Pritchard Consulting Group

From: Jan Bowen, Provost & Pritchard Consulting Group

Subject: DWR Goshen Basin Stage-Storage Drawdown Analysis

Date: April 14, 2015

This memo summarizes the analysis used to calculate the time required to drain the proposed Goshen Basin into North Mill Creek.

Background:

The City of Visalia (City) took over Goshen Basin (Basin) from Kaweah Delta Water Conservation District in the early 1990's. Since then, the Basin has been primarily used for urban storm water layoff for the Goshen Watershed region of the City. Currently, the Basin is only used as a retention basin. The proposed improvement will re-plumb an existing 30 inch inflow pipeline that links North Mill Creek and the Basin to a proposed lift station, allowing for water to be pumped from the Basin back into North Mill Creek. This addition will allow the Basin to operate as a detention basin instead of a retention basin. The Basin will also be regraded, allowing for an additional 17 acre-feet of layoff capacity.

Analysis:

The proposed Basin will operate between water surface elevations of 257.0 feet and 277.7 feet. It was assumed that the pump would discharge into a standpipe that is connected to the existing 30 inch pipeline that links North Mill Creek and the Basin. The discharge elevation into the standpipe was assumed to be 10 feet (289.0 feet) above existing grade. A pump curve (see attached) was assumed based on pump performance curves supplied to Provost and Pritchard by the City. Depending on Basin water surface elevations, pump discharges ranged from 5 cubic feet per second to 7 cubic feet per second. To drain the basin entirely would take approximately 14 days. Discharge from the Basin into North Mill Creek is assumed to occur when the creek has the capacity to handle the additional discharge from the Basin.

Conclusion:

The proposed improvements will convert the Basin from a retention basin to a detention basin, allowing for the Basin to be utilized in back-to-back storm events. The proposed Goshen improvements will allow the basin to be fully evacuated within 14 days.

Attachment:

1. Goshen Basin Drawdown Analysis

DATE:	4/14/2015
JOB NO.:	139113V1
COMP. BY:	JEB
CHKD. BY:	CW
SHEET 1	OF 1

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City of Visalia
DWR Basin - Goshen Basin
Stage-Storage Drawdown

Goshen Basin - Stage-Storage Drawdown Analysis

Analysis assumes the following Conditions:

1) Maximum and minimum basin WSEL is 257.0' and 277.7'.

2) Pump Horsepower is rated at 25 HP.

3) Pump discharges into a standpipe at an elev. of 289.0'

4) Pump curve shown in the figure below.

5) Proposed basin stage-storage relationship shown in table below.

6) 12 in (ID), 40 ft pump column and discharge.

7) Friction losses based on Hazen-Williams formula.

Proposed Goshen Stage-Storage			
WSEL (ft)	Basin Vol. (AF)	Discharge Rate (cfs)	Drawdown (days)
277.7	166.8	N/A	0.0
277.0	159.0	7.1	0.5
276.0	148.9	7.0	1.3
275.0	139.1	6.9	2.0
274.0	129.5	6.9	2.7
273.0	120.1	6.8	3.4
272.0	111.0	6.7	4.1
271.0	102.1	6.6	4.8
270.0	93.4	6.5	5.4
269.0	84.9	6.4	6.1
268.0	76.7	6.3	6.8
267.0	68.7	6.2	7.4
266.0	60.9	6.1	8.1
265.0	53.3	6.0	8.7
264.0	45.9	5.9	9.3
263.0	38.7	5.8	9.9
262.0	31.8	5.7	10.6
261.0	25.0	5.6	11.2
260.0	18.5	5.5	11.8
259.0	12.1	5.3	12.4
258.0	6.0	5.2	13.0
257.0	0.0	5.1	13.6